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PREFACE

TO

REPORTS OF HEADS OF DIVISIONS.

By

A. S. Haynes.

In para: 75 of my Annual Report on the Department for the year 1922 the following is written :—

> "I have been much struck by the interesting and informative annual reports written by some of the Heads of Divisions. To incorporate their reports in this one would render it unduly bulky and would impose on the general reader much detailed information on various aspects of agriculture which are rather special than general. Yet some of the reports contain records of investigations and reviews of work done which should be on record and should be available to those sections of the public who are particularly interested in their several lines; and a perusal of them will illuminate the usefulness and value of the work performed by the various Divisions of the Department, work which by its very nature cannot be brought to the notice of the public day by day.
>
> It is proposed therefore to make a new departure by printing these reports in the Malayan Agricultural Journal, the monthly organ of the Department".

Those words explain the appearance of these reports.

The latter speak for themselves; but it is not inopportune to draw attention to the large volume of valuable work done in connection with rubber and rubber research, revealed more particularly in

the reports of the Agricultural Chemist, the Mycologist, and the Plant Physiologist. The facilities at the offices of the Department which exist for the rubber planter in the vulcanising factory for rubber testing are not perhaps adequately realised : to planters it is a great convenience to be able to bring their rubber to the factory, have it tested and reported on and discuss the results when available with the Agricultural Chemist on the spot.

I cannot leave the subject of these reports without mentioning the fact that the very valuable work done on padi has been summed up recently in an article "Rice in Malaya" by Mr. H. W. Jack, which appeared in the May-September issues of the Malayan Agricultural Journal, 1923 (Vol : XI Numbers 5-9 inclusive) and which is now being printed as a Special Bulletin.

ANNUAL REPORT OF THE AGRICULTURAL CHEMIST FOR 1922.

By B. J. Eaton.

Staff.—The Senior staff consisted of the following Officers :—

B. J. Eaton	...	Agricultural Chemist.
R. O. Bishop	...	Assistant Agricultural Chemist.
C. D. V. Georgi	...	" " "
V. R. Greenstreet	...	" " "
J. H. Dennett	...	" " "

From January 1st to February 8th the Agricultural Chemist was acting as Director of Agriculture during which period Mr. R. O. Bishop acted as Agricultural Chemist.

Five Malay Officers have been attached to the Chemical Division as Assistants; additional subordinate staff and coolies in the Experimental Paper-making Factory are under control of the Chemical Division.

Organisation.—The Agricultural Chemist has been engaged almost entirely on administrative duties and the compiling of reports in connection with enquiries of a varied nature.

Mr. R. O. Bishop has been in direct charge of all investigations on rubber, paper investigations and examination of fibres.

Mr. C. D. V. Georgi has been in charge of all investigations on oils and fats, essential oils, forest products, lime fruit products and other miscellaneous investigations.

Mr. V. R. Greenstreet has been in charge of investigations on soils and fertilisers and various miscellaneous investigations.

Mr. J. H. Dennett has been in charge of all investigations in connection with the production of alcohol and sugar from Nipah Palm, including experimental tapping of the palm, work on coconut toddy, sugar cane, copra, desiccated coconut and other miscellaneous investigations.

In spite of the fact that the present staff is complete for the first time since this staff was authorised in January 1914 much work awaits investigation in many directions.

Malaya-Borneo Exhibition.—Almost the whole of the first three months, including much time outside office hours, was spent by the Chemists in the preparation of exhibits for the Agricultural section of

the Malaya-Borneo Exhibition. These included raw and vulcanised rubber, paper pulp, paper and cardboard from various local raw materials, lime fruit products, sugar and alcohol from various local raw products, vegetable oils and fats, essential oils, fibres, soil samples, peat and peat products.

The opportunity was taken to examine many of the prepared products for record and future possibilities. The officers of the division also contributed to the Handbook of Malayan Agriculture.

Rubber Investigations.

The principal investigations during the year have been the following:—

(*a*) The effect of storage of raw rubber on quality after vulcanization.

(*b*) The cause of the variability of sulphur on vulcanisation.

(*c*) The effect of cinchona alkaloids (especially the bye-products from the manufacture of the crystalline cinchona alkaloids) on vulcanisation.

(*d*) The effect of alum on raw rubber.

(*e*) Further investigations on "slab rubber."

(*f*) Investigation of Singapore Blanket crepes prepared from native sheet.

(*g*) The manufacture of rubber floor tiles.

(*h*) The variation in quality of rubber from tapping of individual trees.

(*j*) The non-caoutchouc constituents of latex.

(*k*) The preservation of latex for shipment.

The following observations in connection with the above investigations are of interest.

(*a*) Raw rubber, especially sheet and crepe, deteriorate on storage in this country. This has been noted in our investigations previously.

(*b*) Although there may be other causes for the variability of sulphur in its effect on the vulcanisation process, it has been discovered that a very small proportion of arsenious and arsenic oxides and other arsenic compounds have a very marked effect on vulcanisation. The problem of variability of sulphur has been attacked from the point of view of impurities in sulphur and other chemicals used

in the preparation of raw rubber and the manufacture of rubber goods and it is possible that impurities other than arsenic may be responsible for variability. It has also been found that certain soluble organic arsenic compounds may be of commercial value in this connection. It is of interest to note that, as far as our information goes, this effect of arsenic has not hitherto been recorded. The opposite effects of different quantities is also of interest.

(*c*) The investigation of the effect of the cinchona alkaloids, especially the non-crystallisable alkaloids remaining in the extract of the bark after the extraction of the crystalline alkaloids—quinine, cinchonine, cinchonidine and quinoidine, was carried out as a result of tests on a product given to the writer while on leave in 1921, which was stated to be used in rubber works. The product is almost certainly quinoidine which is the commercial name applied to the mixture of amorphous alkaloids from cinchona bark, which were not used previously to any extent, as far as the writer is aware. It has since been found that quinoidine is used in America as a vulcanisation accelerator.

(*d*) A further report has been compiled, but not yet published, on the effect of the addition of the alum to dry raw rubber.

(*e*) Investigation on the drying of "slab" rubber prepared and dried under different conditions has been commenced and is in progress.

Since the standard laid down for this grade for Customs purposes is a moisture content of 20 per cent, it is necessary on economical grounds for estates to export slab rubber containing not more than this amount.

Enquiries have also shown that native rubber exported from Perak and sold chiefly by small holders to local rubber dealers is essentially slab rubber. One large Company has exported considerable quantities of this grade of raw rubber during the year but chiefly in the form of dry crepe prepared by machining the matured coagulum and subsequently drying.

(*f*) An investigation of Singapore Blanket crepes from native sheet indicate considerable variations in the quality of these grades due to the use of alum as a coagulant in the Colony.

(*g*) Advice and assistance has been rendered in connection with the manufacture of rubber floor tiles.

(*h*) A report on the quality of rubber from the tapping of individual trees will be prepared shortly.

(*j*) An investigation in conjunction with the Plant Physiologist of the non-caoutchouc constituents of latex and their effect on the quality of rubber during vulcanisation, is in progress.

(*k*) In view of the great interest which is being taken in the export of latex, for the manufacture of latex paper, impregnation of fabrics, cords for tyres, etc., investigations on the preservation of latex with ammonia in the form of a strong solution of ammonia, liquified anhydrous ammonia gas and with other preservatives have been carried out and are being continued.

There appears little doubt that at present for most purposes, ammonia is preferred, although several other substances or combination of two substances are more economical and equally effective for certain purposes. A paper on the use of ammonia has been published in the Malayan Agricultural Journal and another paper has been prepared in connection with other preservatives. Advice in the form of reports and visits, including personal supervision, has been given to a number of estates in this connection. An article on "whole" rubber or desiccated latex has been prepared for publication in the Malayan Agricultural Journal.

Rubber manufacture.—The local manufacture of rubber goods in Singapore appears to be increasing and one firm is manufacturing large numbers of soles for boots and shoes and also complete canvas boots and shoes with rubber soles.

New methods of preparation.—Slab rubber continues to be prepared on two or three estates for certain consumers but cannot be sold on the market. Considerable interest is being taken in the Hopkinson process for the desiccation of latex, which may become a new and valuable commercial process for the preparation of raw rubber.

Alcohol Investigations.

The most promising raw product for the production of fuel or power alcohol appears to be the Nipah Palm, the fruiting stalk of which, when treated by special methods and subsequently tapped in a manner similar to that employed for tapping the coconut spathe (unopened flowering stalk) for the production of toddy, yields a saccharine juice which can be fermented naturally to alcohol. The yield of alcohol is about 6.5 per cent on the weight of the juice. The area of indigenous palms in this country, especially in any one district, is not large. The cultivation of the palm has been taken up already by two syndicates, although our information on possible yields is still somewhat meagre, due to the fact that most indigenous palms have been cut previously for attap, which almost certainly affects the yield of juice on tapping, and also to the fact that the yield of individual palms, as in the case of other economic plants, probably varies considerably.

Two small areas have been reserved for the Department for the experimental planting of Nipah Palms, in order to obtain information on the growth and maturation period of the crop.

A report on the investigations to date is being compiled and will be ready shortly.

Investigations on the production of alcohol from lallang grass have given unsatisfactory results.

Other starch yielding crops e.g. tapioca, sweet potatoes and Jerusalem artichokes will also be considered in this connection, and also the manufacture of sugar from Nipah Palm.

There is a possibility of the revival of the sugar industry which may also be of value in connection with the manufacture of alcohol from molasses. An investigation on the preservation of toddy has also been made, but the work was not completed at the end of the year.

Vegetable Oils and Fats.

Investigations of the following oil seeds, oils and fats and oil cakes etc., have been made :—

Copra, desiccated coconut, copra or coconut oil, oil from desiccated fresh coconut, palm fruits, palm oil and palm kernel oil, croton oil, illipé fat, nutmeg butter, seeds of *Xylocarpus moluccensis* (Nyireh batu) and *Xylocarpus obovata* (Nyireh bunga) (both jungle fruits) cashew nut and oil, chaulmoogra seeds imported from Burma for planting purposes, candle nuts and candle nut oil, kapok seed and kapok seed oil, seed and oil from seeds of *Sterculia foetida* (from Brunei), rubber seed oil, castor seed cake and oil, *Calophyllum Inophyllum*, *Nephelium lappaceum* (rambutan), *Nephelium mutabile* (pulasan) and Curcas (purging nut) seeds.

Of the above oils only coconut oil and palm oil are at present of any real commercial interest and value, although illipé from various islands — chiefly from Borneo and Sarawak — are imported into Singapore. At present however the fat is only expressed occasionally and all the seeds are re-exported to Europe.

A special pamphlet on the manufacture of desiccated coconut products and other tinned coconut products has been prepared and distributed.

Investigations on these products have also been carried out in the laboratories.

It is of interest to note that the proprietor of a copra oil mill in Penang has commenced the manufacture of shredded desiccated coconut near Butterworth. An investigation of the quality of the copra from coconut trees tapped for toddy compared with copra from untapped trees has been carried out. The results showed no important differences in oil content, so that the problem of tapping for toddy

concerns chiefly the yields of copra. An investigation of copra from nuts of different dwarf varieties of coconuts showed no differences in oil content.

Advice and assistance has been given to one estate in connection with the manufacture of palm oil.

Essential Oils.

Investigations on the essential oils of citronella, lemon grass patchouli, American worm seed (Chenopodium oil), clove, nutmeg, and vetiver roots, have been carried out. Distillation of the raw materials on a semi-commercial scale have also been conducted and samples of the oils sent to London for valuation. At the present time there is probably not much profit, except in the case of the more valuable essential oils, such as patchouli and vetiver oil.

Lime and Lime Products.

Considerable advice and assistance has been rendered to one syndicate in connection with the manufacture of lime products.

It is advised at present that attention be paid to the manufacture of concentrated lime juice and hand-pressed and distilled oil of limes. The problem of the manufacture of citrate of lime and more especially citric acid can be considered later, when more experience has been gained by the estate concerned.

Fibres.

Considerable interest has been taken in the cultivation of various fibres but apart from roselle, very little actual cultivation has so far been carried out.

Samples of jute, roselle, sisal hemp, sansieveria (furcrea) or bowstring hemp, Mauritius hemp, pineapple fibre and several miscellaneous fibres have been examined during the year.

Several bales of roselle fibre have been prepared and sent to various firms and individuals.

An investigation of the buoyancy value of Malaya kapok compared with Java kapok has been carried out and a report prepared for publication. The samples examined, which were not of the highest quality obtainable, conformed to the standards laid down by the Board of Trade for the use of this fibre or floss in life-saving apparatus.

Paper and Paper-pulp.

During the early part of the year a large number of exhibits of pulps cardboards, etc. was prepared from various local raw materials includiug bamboos, wood, lallang grass and citronella grass, for the Malaya-Borneo Exhibition. Later in the year, samples were prepared and sent to England and to the Forest Research Institute,

India for valuation and report. Samples were also handed to another applicant who was proceeding to Denmark with the intention of endeavouring to form a Company or syndicate to operate in Malaya.

Arrangements have been made with the Forest Research Officer F.M.S. to obtain further supplies of raw materials in order to continue these investigations.

Forest Products.

A number of resins (Damars) Oleo-resins, wood oils, and oil seeds have been investigated for the Forestry Department during the year and a programme drawn up in conjunction with the Forest Research Officer to continue these investigations during 1923 and subsequently.

Samples of Jelutong Rubber are under investigation in connection with its use as a chewing gum.

A sample of wood from an Entada species (Akar sintok) has been examined and found to contain a saponin.

Soil Investigations.

Over 100 soils have been examined and reported on during the year and over 100 samples are still awaiting investigation or are in the course of examination.

These include 47 samples examined in connection with a padi irrigation scheme and several samples from the Cameron Highlands.

There is nothing of special interest to report in connection with these samples.

Fertilizers.

A number of samples of local guanos and phosphates have been examined and found to be very variable in composition.

Samples of Canton mud and local Chinese fish pond mud, used to a considerable extent for horticultural purposes, have been examined and a report published in the Malayan Agricultural Journal. Several miscellaneous waste products have been investigated in this connection and found to be of little value.

Miscellaneous Investigations.

Under this heading are included samples of acetic acid, sodium sulphite and sodium bisulphite and ammonia received from Estates or Firms. The poor quality of some of the chemicals examined illustrate the necessity for analysis in controlling the quality of such chemicals.

A sample of worm killer was found to consist of illipé seed meal, which contains a saponin useful for the purpose.

A sample of a Eucalyptus fungicide from Australia and a sample of a chemical recommended for the prevention of "spot" disease on prepared raw rubber have been investigated.

Three samples of barium carbonate used for rat destruction and two samples of lead arsenate used as a spray for the destruction of cockchafers were examined.

Two samples of water were examined.

One sample of tobacco for nicotine content was examined. Samples of tobacco grown on Serdang Estate are also under investigation for nicotine content. The object of these investigations is to cultivate tobacco with a high nicotine content for use as an insecticide.

Publications, Lectures, Etc.

Apart from contributions to the Handbook of Malayan Agriculture, the Agricultural Chemist prepared an article on Malayan Agriculture in connection with the visit of H. R. H. The Prince of Wales and also contributed the section in Agriculture to a book on the Geography of Malaya edited by Dr. Winstedt. Numerous articles on various subjects have been published in the Malayan Agricultural Journal during the year by the staff of the Chemical Division.

A lecture on "New uses for rubber and the preservation of latex for shipment" was delivered by the Agricultural Chemist before the Kajang District Planters' Association and published subsequently in "The Planter."

A feature of work during the year has been the large number of enquiries in connection with products other than rubber and the number of special reports prepared on various subjects, together with a large number of interviews.

Local Industries.

Investigations and enquiries are being made in connection with various local industries and the establishment of new industries.

There are a number of small soap factories in the Federated Malay States and the Colony and it is hoped to be able shortly to assist and advise these in connection with their products. Apart from the desiccated coconut factory mentioned previously a pineapple canning factory has been erected in Klang and there is a probability of starting a rubber works in the Federated Malay States. In connection with the manufacture of coconut oil the writer was informed recently that the oil mills in Singapore at present found it difficult to dispose of oil, although there is no difficulty in exporting copra at a fair price.

The cultivation and distillation of the more valuable essential oil plants such as patchouli and vetiver should prove remunerative.

So far, sugar cultivation has not been revived, although land has been acquired for the purpose. The manufacture of industrial alcohol from the Nipah Palm should prove a useful local industry, if the cultivation of the palm proves an economic success.

It is hoped also that the output of Palm oil and the expression of palm kernel oil and the manufacture of various lime products will prove an economic success.

Considerable interest has been taken in the manufacture of various articles, especially soles for boots and shoes and mats from raw rubber. The Peachey process of vulcanisation has not yet been established in the East, but the Schidrowitz process of vulcanisation is being tested on scientific lines on one estate.

The Lamb process of vulcanisation also continues in operation in Johore. Considerable interest is being taken in the export of latex for the manufacture of latex-paper and also for the impregnation of fabrics and cords for tyre manufacture.

It is possible that such materials might be treated locally.

Interest is also being taken in the desiccation of latex as a new method of preparation of the raw product and it is possible that the process may be instituted in the Federated Malay States.

General.

The Experimental Vulcanising Factory and the Experimental Paper-making Factory, together with decorticating machinery and baling press for fibres have been under the control of the Chemical Division.

ANNUAL REPORT OF THE CHIEF AGRICULTURAL INSPECTOR FOR 1922.

By F. W. South.

I.—Staff.

For the first time for about four years the division has had a complete staff of European officers during the whole year. This has had a beneficial result on the general efficiency of the work and has enabled the division to make a successful start with several new lines of work which it is hoped will lead to results of considerable value.

There were very few changes among European Officers. On January 1st Captain S. D. Timson, M.C. assumed duty as Assistant Agricultural Inspector, Penang, Province Wellesley and the Dindings, thus relieving Mr. F. Birkinshaw, Assistant Agricultural Inspector, Perak North of his additional duties in the Colony.

On August 3rd, Mr. A. G. G. Ellis, Inspector of Agriculture, Johore, proceeded on leave to Europe. Mr. A. E. C. Doscas was seconded from Negri Sembilan to act as Inspector of Agriculture in his place, and Mr. W. N. Barnes, Special Field Officer, Kuala Pilah was appointed to act temporarily as Assistant Agricultural Inspector, Negri Sembilan in place of Mr. Doscas. Mr. Ellis resigned the service in November and the acting appointments were continued until the end of the year. There were no other changes.

Special Field Officers.—By the end of June the services of all three of the Special Field Officers employed on the control of Pink Disease in Ulu Selangor district had been terminated, as the situation there had much improved.

In Negri Sembilan three Special Field Officers were working on the control of Mouldy Rot disease from the beginning of the year until the end of July, when one, Mr. W. N. Barnes, commenced to act as Assistant Agricultural Inspector, Negri Sembilan. The services of the remaining two officers were terminated on November 30th, as it was considered that after that date the work could be done by the normal staff.

Such transfers have been made among Malay Officers as have been necessary for training purposes; qualified officers have received promotion; and three Apprentices unable to qualify for promotion have had their services terminated.

In the Colony and in Johore the whole staff of Malay Officers on the departmental schemes is still in training. This means that at present only a proportion of them are available for field work at any given time, as some are always at headquarters, taking lecture courses and working in the laboratories.

Recruiting of the Malay Staff has been handicapped by the necessity for economy. It is to be hoped that this necessity will not continue long enough seriously to impair the efficiency of the division; more especially now that it is undertaking the important instruction duties described in the following paragraphs. It is clear that the division cannot attain its best results until the staff has been fully established and trained, so that officers can settle down in their respective districts and continue in them for some time without being transferred.

Instruction Duties of the Inspection Staff.

From the first of July an arrangement was approved whereby the inspecting officers add to their duties certain lines of Instruction work necessary to bring to the knowledge of the planter and, in particular, of the Asiatic cultivator the results of the experimental work carried out by the research officers at headquarters. Such lines of work include the running of Experiment Stations for padi and possibly for other crops; the establishment of padi testing stations to test the suitability of pure strains under varying local conditions; the planting of demonstration plots for pure strains of padi and for new crops likely to be suitable for small holders; the distribution of seed, especially padi seed; and the giving of advice to small holders on any subjects of interest to them.

To obtain the best results it will be necessary for all inspecting officers to gain the confidence and interest of those among whom they work. For this reason it is desirable to retain officers for as long as possible in the same areas and to avoid transfers, so that each officer may become personally known to those for whom he is working.

This scheme has only been in operation for six months. It is a purely tentative arrangement at present to avoid the heavy expenditure entailed in providing an entire, new Instruction staff. The beginning, however, promises well. The work of the inspecting officers is certainly rendered far more interesting, while several useful lines of work have been started, and no administrative difficulties likely to interfere with the smooth working of the scheme have, so far, been experienced.

II. Estates Visited.

The total number of estates visited throughout the Federated Malay States, the Colony, and Johore was 326, of which 97 were visited more than once, and 119 by request.

This compares with 160 estates visited in 1921 including 33 visited more than once. A large number of these visits have, as usual, been for the purpose of advising on the control of pests and diseases; but in several instances thay have been connected with the growing of new crops, or of crops other than rubber.

III. Diseases and Pests of Rubber.

1. Stem Diseases.

Pink Disease. (*Corticium salmonicoler* B. & Br.). This disease was newly reported from 40 estates in the area covered by this report, making a total of 328 estates from which it has been reported. In all 1734 notices were served requiring the treatment of the disease. Failure to comply with the notices led to 106 prosecutions, of these 100 persons were convicted and fined sums amounting to a total of $1,668/- with $14.75 costs.

The disease was found in three widely separated localities in Penang island for the first time. Two of these are on the western side. The previous freedom of the island from this disease, combined with the fact that the affected holdings are not less than 15 miles from the nearest centre of infection on the main land, suggests that the fungus was introduced through the agency of birds.

In about four instances it has been necessary to insist on the proper treatment of this disease on European owned estates where it had been neglected for reasons of economy. In two or three cases the advice of the department has been sought for improvement of the control measures in use, since they were proving ineffective; mistakes have been pointed out and rectified. The Inspector of Agriculture, Johore, discovered that the disease was often prevalent on Japanese owned estates because the Managers were ignorant of its nature and treatment; he has, therefore, given special attention to advising these estates.

The routine control measures have been regularly enforced everywhere, so that the disease is well in hand is most areas. Early in the year special measures for reducing its prevalence in Ulu Selangor district were in progress under the Special Field Officers and the Junior Agricultural Assistant, Ulu Selangor. These proved effective and the disease is now considerably less prevalent. Demonstations of the proper treatment were given and had good results. The situation had so much improved that it was possible to dispense with the services of all the Special Field Officers by the end of June. The Junior Agricultural Assistant has since been able to keep the disease well under control by himself. There has been no large spread of the disease. An area near the Sungei Buloh Forest Reserve in Selangor, where there is much young rubber, became infected early in the year and two or three estates have had to establish pest gangs to keep the disease under control. Sporadic attacks appeared in Kinta district and around Kuala Lumpur, where cases are only occasionally found. These received prompt treatment and the fungus did not spread.

A small pamphlet and standard instructions for the treatment of the disease to be attached to Notices served under the Agricultural Pests Enactment were prepared by the Chief Agricultural Inspector and translated into Chinese, Tamil and Malay.

2. *Bark Diseases.*

Mouldy Rot. (*Sphaeronema fimbriatum* E. & H.). This disease was newly reported from 11 estates in Negri Sembilan, 2 in Selangor, 1 in Perak and 6 in Johore, making a total of 74 estates from which the disease has been reported. In all 3,188 notices requiring its control were served. 299 persons were prosecuted for failure to obey orders and 261 were convicted. The total fines inflicted amounted to $1,083.50 with $171.50 costs.

In Negri Sembilan the work of the Special Field Officers has led to a general recognition of the disease in all infected areas and a general knowledge of the methods of treatment and control. It has, however, been impossible completely to eliminate the disease. This is partly due to the fact that the fungus possesses spores very resistant to drought which enable fresh infections to appear in damp weather, even when the trees have been healthy for some time; and partly because, owing to poverty, small holders cannot be induced to cease tapping their trees, sick and healthy trees being tapped alike. In such circumstances the disease is always present though kept under control by painting with disinfectants.

In was considered towards the end of the year that the work of the Special Field Officers had had its full educative effect and that no other result could be expected from it. Consequently the services of the two then remaining were terminated on November 30th and the control work was left in the hands of the normal inspecting staff.

The disease has on the whole spread slightly in Negri Sembilan having reached the Selangor boundary at Batang Benar and extended into new areas around Kuala Pilah. The actual percentage of trees affected is, however, distinctly less; while regular painting, which is usually carried out, prevents very serious damage to the bark from this fungus.

There has been no extension of the infected area around Mentakap in Pahang.

In Johore there has been no very marked extension of the infected area, but various local difficulties militate against its successful treatment. One of the worst infected areas is the coastal land between Batu Pahat and Muar where the conditions are unsuitable for rubber, owing to the high water table.

At the beginning of the year the only infection in Malacca was on one estate near Gadek where the disease was regularly treated and at times entirely absent. In the second half of the year, however, it appeared at four new centres, namely Sungei Rambai, Sebatu, Batu Gajah and Chin Chin. These are all on the Johore boundary and were almost certainly infected from the Muar district, probably by wandering tappers. The disease in this area is entirely confined to small holdings mostly owned by Chinese who have to be taught the need for treating it and the method of treatment, and then often disregard orders entirely. Consequently control is not easy and numerous prosecutions become necessary.

In October the disease was found in a belt of small holdings at Sepang about 3 square miles in extent. The Assistant Agricultural Inspector, Selangor, gave a demonstration of the treatment which was well carried out with satisfactory results, as only 5 owners failed to treat their trees thoroughly. These were summoned and fined.

During November and December the disease was reported on two estates in Selangor on the Negri Sembilan boundary in Ulu Langat district. It was promptly and effectively treated. No small holdings in this area were attacked.

In both cases the disease had probably spread into Selangor from adjoining infected areas in Negri Sembilan.

Towards the end of December one estate near Padang Rengas in Perak with an adjoining area of 3-4,000 acres of small holdings was found to be infected. Prompt measures were taken to ensure treatment and these promise to be effective.

It is difficult to see how the spread of this disease to all parts of the Peninsula is to be prevented. Infection is easily carried on the knives and clothes of wandering Chinese and Javanese tappers. Reports of outbreaks on small holdings are scarcely ever made by the owners, so that such have to be discovered by the inspecting officers who can only visit any given part of their district periodically, and may thus not find the disease until it has been established for a few weeks.

The department has continued to render available supplies of suitable disinfectants to small holders at cost price.

Black Stripe (*Phytophthora sp.*) This disease was newly reported from 3 estates in Selangor, 1 in Negri Sembilan and 2 in Johore. Making a total of 115 reports in all. There were 54 notices served requiring its treatment and 4 persons in Pahang who failed to comply with the orders were fined a total of $59/- with $2/- costs.

The disease was present on certain previously infected estates in Perak, but received regular treatment. It has also been present on certain estates in Selangor and on a few small holdings chiefly in Ulu Langat and Kuala Selangor districts. The disease is still present in Jelebu district of Negri Sembilan and in parts of Pahang, especially Temerloh and Kuantan districts. Two small outbreaks have been recorded in Johore. On the whole this disease has been of little importance during the year.

Brown Bast. This bark affection is noticeable everywhere on small holdings where affected trees have not been thinned out and heavy tapping still prevails. It is far less common than formerly, on estates, probably owing to the more conservative tapping systems that are now almost universal.

3. *Root Diseases.*

Fomes lignosus. Klotsch. This root disease has been present as usual in fields of young rubber in various parts of the country. In the Director's Annual Report for 1921 attention was called to the fact that a thick cover crop on land not cleared of timber will assist the spread of the disease. Instances of this have been recorded by the Assistant Agricultural Inspector, Perak North. It is certainly advisable to remove all lying timber before planting a cover crop. Experiments were conducted by the Assistant Agricultural Inspector, Perak North, to determine if all infected jungle stumps, standing in a cover crop on a young clearing, could be discovered by periodical examinations to ascertain if the fruits of the fungus were present on them. It was found, however, that such examinations did not reveal all infected stumps, because the fruits develop irregularly and do not last long. The most satisfactory system is undoubtedly to remove all stumps as well as lying timber before planting a cover crop; but if care is exercised and all affected young rubber trees, and jungle stumps seen are promptly treated, it should be possible to prevent serious loss, even if the jungle stumps are not all removed.

In Province Wellesley *Fomes lignosus* has been observed in certain instances to spread from buried coconut stumps and trunks and cause the death of an abnormal number of the surrounding rubber trees. Attention has been called in the past to the danger of burying cocouut stumps and timbers between rows of rubber trees. Vide *Agricultural Bulletin*, Federated Malay States, Vol. VI. p. 269.

The Inspector of Agriculture, Johore, noticed that, owing to lack of knowledge, *Fomes lignosus* is often left untreated on Japanese estates in Johore and is in consequence often found on such estates attacking mature trees. He has spent much time giving field demonstrations and general advice regarding its treatment on these estates and his efforts appear to be appreciated. He intends to give regular demonstrations in pre-arranged areas to Japanese, as they control large areas of Rubber in Johore.

One or two instances have been recorded of damage to fields of old rubber trees by wet rot *Fomes pseudeferreus* Wakef, dry rot *Ustulina zonata*, (Lev. Sacc) and brown root disease all working together in the same area. Such outbreaks have invariably been due to the facts that the decaying timber has been removed from these fields too late and, in some cases, that thinned out rubber trees have not been burnt promptly. In Johore wet rot disease does not appear always to receive the attention it deserves. In one instance it was found on a clearing only two and a half years old.

During the year 39 notices were served requiring the treatment of root diseases. There were no prosecutions.

Other diseases of rubber such as patch canker, die back and *Sphaerestilbe repens* B. and Br. have been observed, but do not require further record.

4. *General Sanitation.*

The policy of requiring the removal of dead rubber stumps and timbers from small holdings has been maintained. In all 521 notices were served with this object. Two persons who did not carry out the instructions in Malacca were prosecuted ; one was convicted and fined $25 and costs 50 cents.

All rubber stumps have been removed from the road sides and Crown lands in Malacca, but similar work still requires to be done in Singapore.

Thirty-one notices were served on account of extremely bad tapping such as would render the trees liable to attack by pests and diseases. There were no prosecutions.

IV. Diseases and Pests of Coconuts.

1. *Diseases.*

A few cases of bud-rot and of leaf spot caused by *Pestalozzia Palmarum*, Cooke, have been recorded but neither disease has been of much importance. One or two new diseases are under investigation. On an estate in Perak North young dwarf palms were observed to die after germinating successfully. The cause of this is under investigation.

2. *Insect Pests.*

Beetles. Black Beetle (*Oryctes rhinoceros* L.) and Red Stripe Weevil *Rhyncohphorus Schach*, Oliv). The routine work of destroying dead coconut stumps and timbers, dead stumps and timber of other palms, village refuse and accumulations of cattle manure likely to serve as breeding places for these beetles has been continued steadily throughout the year. Good progress has been made in Penang, Province Wellesley, Bagan Datoh district of Perak, the coastal area of Selangor and in Singapore. Beetles are now far less numerous in these once badly infected areas and the coconut trees often show an improvement in yield as a consequence. In other parts of the country these insects have not been much in evidence. Malacca is now comparatively free from them owing to the work done in the past. In Johore breeding places, of the black beetle especially, are fairly numerous.

In all 4,900 notices were served requiring the destruction of possible breeding grounds for beetles. Owing to failure to comply with these orders 268 persons were prosecuted and 241 were convicted and fined sums amounting to $819.75 with costs $118.89.

In Pahang one man was fined $10 and costs 50 cents for felling coconut trees without permission.

Brachartona catoxantha, Hamp. During the last quarter of the year slight outbreaks of this caterpillar pest were reported in Selangor, one at the 6½ mile on the Kuala Selangor-Sabak Bernam road, the other at Sabak Bernam.

Thosea sp. A small attack by the caterpillars of this insect occurred on about 10-15 acres of coconuts at Sungei Batu in the South-west of Penang island during September. When discovered in October the attack was over. Possibly it was terminated by parasites of the insect. The foliage of the attacked trees was rather badly damaged.

Grass-hoppers. In a few instances grasshoppers, principally *Cyrtacanthacris luteicornis*, Serv., have damaged the leaves of coconuts; on two estates in Selangor, on which giant mimosa (*Mimosa invisa*, Mart) was grown as a cover, grasshoppers, mostly *Orthocanthacris nigricornis*, Burn., damaged the mimosa and then attacked the young coconuts.

Manila Beetles (*Diocalandra frumenti* F.) Specimens of these weevils were found in decaying parts of living coconuts on an estate in Selangor and were believed to be causing damage. These insects are always found feeding on decaying material and it is most improbable that they are ever responsible for any direct damage to coconut trees.

Other pests which have been recorded in different parts of the Peninsula as causing some damage are; the "greater" coconut spike moth (*Lirathaba* sp. near *trichogramma*, Meyr.); the "lesser" coconut spike moth (*Batrachedra arenesella* Walk.); Skipper caterpillars, mostly *Hidari irava*, Meyr.; and *Plesispa reichei*, Chap. on young coconuts. Rats and squirrels are so universal as to require no special mention.

V. Pests of Padi.

Generally speaking the 1922-23 padi crop has been remarkably free from pests, very little serious damage has been caused anywhere by pests other than rats.

Nymphula depunctalis, Gn. Owing to the damage done to the 1921-22 crop at Matang Road by this insect and *Parnara mathias*, F., a strict look out was kept early in the 1922 planting season for the first appearance of the former pest. As soon as it appeared on the young plants in the nurseries spraying machines were provided, and the cultivators were instructed to spray all affected nurseries with a solution of tuba root. The pest was found to be prevalent, breeding on grasses which overhung and grew in the water in canals and distributaries. As soon as there was sufficient water to flood the bendangs the pest spread to the grasses growing therein. Control measures, therefore, consisted of clearing all grass from canals and distributaries. In this work the Executive Engineer rendered ready assistance by clearing up the road drains and larger canals. The cultivators cleared the grass from all smaller distributaries. Through the District Officer and the Penghulu pressure was brought to bear to enforce the simultaneous "menajak" of all bendangs with fairly successful results. Up to the end of the year the padi in this locality has suffered much less from pests than it did last year, probably owing to the early inauguration of control measures.

Nymphula depunctalis was also recorded to a small extent in Province Wellesley.

Stem borers. (*Schoenobius incertellus* Wlk., *Diatraea auricilia*, Dudg., etc.). The various species of these insects occurred everywhere in Krian on the 1921-22 crop; they were present in Province Wellesley, and in Krian and Kuala Kangsar districts in Perak on the 1922-23 crop to a less extent. In Selangor advice given by Malay Officers to burn stubble after harvesting has had good results generally as regards controlling these pests.

Other caterpillar pests recorded during the year on padi in Province Wellesley and in Perak North were *Parnara mathias* and *Spedoptera pecten*, Gn.

Leptocorisa sep. These large bugs which suck the young grains of padi soon after the seed has set are known in Province Wellesley by the Malays as "Chenanggong" and elsewhere in the Peninsula as "Pianggang". They did considerable damage to padi near Raub in Pahang at the beginning of the year. Poisoned meat baits were tried as a control, but with uncertain results. They were present, but only to a slight extent, in various localities throughout the Peninsula at the end of the year.

Nephotettix bipunctatus, F. These insects did some damage in two localities to the 1921-22 crop in Perak North, and in one locality in Province Wellesley to the 1922-23 crop.

Podops coarctata, F. "Bena Kura" or Kutu Bruang." These insects were found in padi stubble in Perak South, thus proving that they can exist between crops. They did considerable damage in one area at Bandar.

In Pahang East they were less prevalent in 1922 than is usual. They were found doing some damage at Sri Menanti, Muar in Johore.

Mole crickets. (*Gryllotalpa sp.*) "Sesorok". These did some damage at Bandar in Perak South in an area of young padi that was dry. The insects disappear when the bendang becomes wet. A proper system of water control would appear to be the only satisfactory method of combating both Podops and Mole Crickets.

Rats. This pest has been, as usual, present everywhere and has done a considerable amount of damage. A supply of ½ ton of barium carbonate was obtained from Europe early in the year and distributed to all the Assistant Agricultural Inspectors for sale by them and by District Officers to Malay padi growers at cost price, namely 1 cent. per oz. Careful instructions were given as to the method of preparing poisoned baits. The supply became exhausted before the end of the year and a fresh supply was ordered by cable, but had not arrived at the close of the year.

The poison seems on the whole to have acted efficiently. There was a complaint that part of the supply was not satisfactory from

one district in Selangor, while in Negri Sembilan the Malays consider that barium carbonate is effective against the small rat, but not so effective against the large rat, "Tikus mondok". Reports from Malacca are variable, but success has usually followed when the baits have been properly prepared and used. Heavy rains occasionally render the poison useless by washing away the baits. It is difficult to determine the efficiency of poisoning exactly, as dead rats are not often found, they die in their holes or in water. Malays are liable to doubt its efficiency if no dead rats are found, but on the whole, judging from the demand, the sale of supplies at cost price has been successful.

Traps have given good results at the Experiment Station in Malacca this year and in other localities in the past and should be used to supplement the poison. It may be possible to stock traps and sell them at cost price in the coming year.

Rat control would be assisted if the padi cultivators could be induced to keep the land surrounding bendangs and sawahs free from tall grass and blukar which shelter 'rats; and also to remove the mounds of earth so frequently seen in padi fields, in which rats can make holes without reaching the water level.

As stated last year, the best results cannot be attained until all these measures are systematically applied by all owners of land in a given sawah or bendang, from the commencement of the planting season until the harvest.

VI. Lalang and Blukar.

Throughout the country a number of small rubber holdings have become covered with lalang and blukar. Owing to the poverty of the owners caused by the low price of rubber, it has not been considered advisable to insist that such holdings be cleaned. Where the lalang has threatened to spread into clean land orders have been given that a strip 1 chain wide be cleared along the boundaries. Where mouldy rot disease occurs it has been necessary to require that the undergrowth, when present, shall be kept cut.

On coconut holdings an attempt has been made to insist on the cutting of bushes and a reasonable degree of cleanliness.

Numerous instances on estates have shown that Giant Mimosa, (*Mimosa invisa*, Mart:) can form a cover capable of smothering all lalang present on young clearings where the soil is suitable. It is, however, as yet uncertain how long the cover crop must be present before the roots of the lalang die. In some instances, after a period of not less than 12 months the mimosa itself has died down, though self sown seedlings have appeared which may renew the cover, this is at present uncertain. If the cover dies in this way, it is quite possible that some of the original lalang, where it has been present, may retain enough vitality after only 12 to 18 months to grow again vigorously and cause trouble. Further observations are necessary on these points.

In the meantime experiments are being started on a few native holdings in Perak North to test the use of giant mimosa for eradicating lalang on such holdings.

In all 3201 notices were served requiring the clearing of holdings from lalang and blukar, of these over 2,000 were served in Johore. For failure to comply with the orders 263 persons were prosecuted, of whom 231 were convicted and fined a total of $639 with $94.10 costs.

VII. Water Hyacinth (*Eichhornia crassipes*, Solms.)

In Province Wellesley this weed has blocked many drains in the Sungei Acheh district which are being cleared by the Public Works Department at the request of the Assistant Agricultural Inspector.

In Perak North the gang formed two years ago to control this pest in Krian and elsewhere has worked steadily throughout the year. The Perak river was cleared once between Kuala Kangsar and Ayer Mati in the mukim of Bota, the work lasting from mid June to the end of August.

A considerable amount of work has also been done in Perak South. The Perak river has been thoroughly inspected from the Kuala Kangsar boundary and all places noted where this pest is growing; several tributaries were cleared. State land near Kampar was cleared of the weed by the Assistant Agricultural Inspector, Perak South, and mining land in the same neighbourhood by the owners. The Sanitary Board, Teluk Anson, cleaned up patches of the plant near the town. Work will be continued in 1923 with the assistance of the District Officer, Lower Perak, who kindly supplies reports of the presence of the weed through his Penghulus.

In Selangor patches of the weed on State land have been removed and privately owned land has been cleaned by the owners. The Collectors of Land Revenue have co-operated in this work.

In Pahang East a few patches of the plant were removed. None was seen by the Assistant Agricultural Inspector for the last 4 or 5 months of the year.

In Negri Sembilan the number of places where the Water Hyacinth is found has been largely reduced; where found it is usually in very small quantities.

In Johore the control of this pest is in the charge of the land officers, not of the Agricultural Department. The Inspector of of Agriculture reports that it is cultivated by Chinese gardeners and pig-breeders throughout the State. It has also been noted growing in Government waterways.

The total expenditure on the destruction of Water Hyacinth in the Federated Malay States in 1922 was $1,935.78 from a vote of $7,000. This in itself is evidence that the pest is well under control. In Negri Sembilan 12 persons were prosecuted for keeping Water

Hyacinth on their premises, of these 11 were convicted and fined $188 with $8.25 costs.

VIII. Pests and Diseases of Other Crops.

Giant snails. (*Achatina fulica*). This snail was reported for the first time at Butterworth in the compounds of houses by the sea-shore. It was apparently introduced from Kedah about 11 years ago by Chinese duck-farmers, who used it as 'feed' for ducks, into an estate in the north of the Province. From there the snails were apparently carried in some lilies obtained from that estate and planted in a garden at Butterworth. At the time the presence of the pest was first reported to the Assistant Agricultural Inspector (April), there were considerable numbers of the snails to be found in the area affected, about 10-15 acres. The owners of the houses in the area reported that the pest was doing much damage to their flower gardens, but the Assistant Agricultural Inspector has found no damage of any importance to any of the staple crops.

The owners of the compounds were advised to collect and destroy the snails daily, and this, together with the unsuitable conditions obtaining in the "Snail area", has so reduced the numbers of the snails that very few are now to be found.

Dieback of Cloves. It has been observed that quite a number of the clove trees in Penang island show a die back of which the cause is at present uncertain. The growers state that it is usually only the trees of some age which show these symptoms, but the statement needs confirmation. The damage is sometimes associated with the presence of tunnels in the branches made by the larvae of a boring beetle. It has been noted that Nutmeg and cashew nut trees, "Janggus" in Malay, (*Anacardium occidentale*, L.) growing near Cloves are also attacked by a stem borer.

Oil Palm. (*Elaeis guineensis*, Jacq.) This palm is occasionally subject to a bud-rot and to a disease known as "bent leaf" which commences while the young leaves are still folded in the bud. "Bent leaf" is most usually found on palms under 4 years old. The leaves are not entirely destroyed, but expand and harden though remaining curiously curved. The palms usually recover and become normal. Both diseases are under investigation by the Mycologist.

Rats do much damage to the fruits of bearing palms. They are apparently attracted in large numbers by the strong smell of aniseed given off by the flowers. The rats live in the palms and eat the fruit in all stages of its development, prefering it apparently to other food, as they do not eat poisoned baits.

Roselle. (*Hibiscus subdariffa, L. var. altissima*). Numerous diseased specimens of this plant have been sent in for examination during the year. A root disease attributed to *Fusarium sp.*,

nematode attacks on the roots, and a bacterial wilt have been recorded. Aphids have been found to cause curling of the leaves and mealy bugs have done damage. The cotton stainer, or red soldier, (*Dysdercus cingulatus*, F.) is commonly found on the plants, especially on the fruits. This last pest is common on several species of malvaceous plants including Kapok (*Eriodendron anfractuosum*, D.C.) and cotton.

Citrus. Numerous pests are found in limes, oranges and pomelos all over the country. Collections of these have been made and sent to the Entomologist for record of distribution. Caterpillars of *Prays citri*, Mill., which bore into the rind of the pomelo and other citrus fruits, are common and cause considerable damage.

Mango. The larva of a boring beetle (*Rhytidodera simulans*, White) is a common pest of mango trees. It did considerable damage to mango and durian trees in Ipoh. The pest causes the death of the branches, on which the dried brown leaves hang without falling. The attack at Ipoh was checked by cutting off and burning all the diseased branches and giving the trees a dressing of manure to stimulate growth.

Banana. The leaf-curler caterpillar (*Erionota thrax*., L.) one of the skippers, is a common pest of bananas everywhere, attacking the wild plant, or cultivated varieties, alike. Usually even when present in considerable numbers it does not produce much effect on the plants.

Grasshoppers. Various species of these insects have done damage to miscellaneous crops on two estates in Pahang also to covers of Giant mimosa and to the young palms on fields of young coconuts. Their prevalence seems to depend largely on weather conditions.

Loranthus spp. Various kinds of Mistletoe, " Dalu Api ", " Api Api " or " Dalu Gajah " are commonly to be found on fruit trees, rubber and shade trees. This pest is very common in Negri Sembilan and in parts of Selangor. Steps are being taken to ensure its removal when found, as it does serious damage if neglected.

Numerous specimens of minor pests and diseases have been submitted to the Entomologist and Mycologist for identification and record.

Collections of certain living pests of importance were made at the request of the Entomologist and forwarded for his use at the Malaya-Borneo Exhibition.

IX. Notes on General Agriculture.

1. *Rubber.*

The price of rubber went as low as 23½ cents per lb. during the year, but, with the prospect of Restriction in October and the accomplished fact in November, the price rose until it was 50 cents per lb. at the end of the year.

The long period of depression has not been without good results. It has caused a considerable reduction in the cost of producing a pound of rubber, usually without serious ill effects to well conducted estates though in some cases economies have been effected by insufficient attention to drainage, disease treatment and general sanitation. It has led to a general policy of substituting cover crops for clean weeding, or of growing low grasses in strips on steep hillsides liable to wash where cover crops cannot be established. The increased use of soil covers should have a beneficial effect, not only on the rubber trees on the estates, but also on padi lands lying below estates, since such lands have in several instances been rendered less productive by the accumulation of silt washed on to them from surrounding clean clearings. It has caused the planting community to take a marked interest in the possible cultivation of crops other than rubber and coconuts.

It is to be hoped that a rise in the price of rubber will not destroy the interest in new crops, nor lead to an undue increase in the costs of production.

The general systems of tapping now in favour on estates are more conservative than they have ever been, one cut on $\frac{1}{2}$ or $\frac{1}{3}$ of the tree tapped every other day is a common system, while daily tapping for periods of varying lengths followed by resting periods are also systems in common use. The value of alternate periods of tapping and resting has not as yet been fully determined.

Low prices caused cessation of tapping on many small holdings and resulted also in their neglect or even abandonment in numerous instances. On others, before restriction was introduced, the trees were excessively tapped to make up for the low price by increased yields. Cessation of tapping has had a useful effect on such diseases as black stripe and mouldy rot.

Much interest is still evinced by planters in the possibility of improving the yields of rubber trees by bud-grafting from selected mother trees. Many planters have been making experimental buddings for the purposes of becoming proficient in the method and of training coolies should they be needed later. A few estates have have established large areas of budded trees. The selection of suitable mother trees has, however, not proceeded far in the Peninsula; results obtained from the publications of Dutch Scientists show that the work is still in an experimental stage, and further investigation is necessary before it is certain that increased yields will result from bud-grafting. It is extremely doubtful if the very high yields at first predicted will ever be realised.

2. *Coconuts.*

At the beginning of the year the price of copra was about $11 per pikul, but it fell gradually and was at just over $9 per pikul, when the year closed. In 1921 the price of copra varied from $10 to $13. In Malacca the price of nuts was 2 cents each in the kampongs and 4 to 5 cents in the market, so that nuts were slightly cheaper than in 1921.

The Commissioner of Trade and Customs has kindly supplied the figures showing the export of copra from the Federated Malay States.

States.	Quantity in Pikuls.			Value of Dollars.		
	1920.	1921.	1922.	1920.	1921.	1922.
Perak ...	330,329	436,054	698,939	7,369,345	5,416,972	6,624,465
Selangor ...	82,225	163,516	214,266	1,697,393	2,054,315	1,982,730
Negri Sembilan	4,270	1,501	5,970	89,364	21,088	54,617
Pahang ..	3,164	7,269	9,449	60,484	77,326	83,753
Total ...	419,988	608,340	928,619	9,216,586	7,569,701	8,745,565

The steady increase during the last three years of the quantity of copra exported is of interest. It may be expected to continue for some time, as there are still considerable areas of young palms not yet in bearing.

A factory for the preparation of dessicated coconut was opened in the Province and was operating successfully at the close of the year.

A few areas have been planted up with dwarf coconuts, but in general the usual tall variety is preferred. At present more information is required regarding the yields to be obtained from dwarf palms over a period of years.

It would appear that the preparation and marketing of copra by small holders offer scope for co-operative methods, since, at present, most of the copra is prepared by local Chinese dealers, who take at least such middlemen's profits as might well go direct to the growers of the nuts.

3. *Padi.*

In Penang and Province Wellesley the 1921-22 crop was reaped in January to March 1922 and proved to be considerably under the average owing to unfavourable rains at planting and at harvest, that caused a great deal of damage. This loss supplies a good example of the advantages that might be obtained in these localities by a system of irrigation which would give a controlable water supply.

Very favourable conditions have been experienced during the present growing period (1922-23), and there is every prospect of an exceptionally heavy crop. One danger, however, threatens, which is the presence of excess water in the bendangs, where the padi was ripening rapidly at the close of the year. If the padi is "laid" by storms, part of it may sprout in the ear and so be lost. This danger could be avoided by a proper system of water control.

The potential yield of the 1921-22 crop in Perak North could be described as well up to the average, although the actual yield in many localities was considerably reduced by rain during harvest.

Owing to the unseasonable weather at the time, the planting oe the 1922-23 crop in Perak North was delayed in all districts, in some mukims by as much as a full month. At the end of the year the crop looked promising.

In Negri Sembilan the padi crop in many districts was partly spoiled by a shortage of water soon after planting and by floods and heavy rain at harvest time. In Jelebu district, however, where the date of planting was altered, the crop which is expected in February is more promising.

In Pahang East the 1922-23 padi crop promises to be good and well above the average for the East coast.

In Malacca the padi harvest for the season 1921-22 was fair, though damage from rain and rats was reported from some districts.

Judging from the appearance of the 1922-23 crop at the close of the year, it seemed as if more than ordinary loss would be suffered by padi cultivators, at the coming harvest. Continued heavy rains at the outset flooded many sawahs entirely, necessitating replanting once or even twice. Padi planted early made good progress and promised heavy yields, but long periods of heavy rain, combined with the weight of the padi ears, caused much padi to be "laid," so that much grain will probably be lost.

In Johore the cultivation of padi is at present carried on on a very small scale, but it is hoped materially to extend the area under cultivation by giving every assistance to growers to improve the varieties grown and increase the yield, and also by helping in the control of pests and diseases.

About two hundred acres of sawah land at Kampong Lukut in Kota Tinggi district is cultivated by Negri Sembilan Malays who emigrated to Johore about 20 years ago. The crop there gave promise of being good. The average yield was estimated at 450 gantangs per acre.

On the majority of such other sawahs as exist the land received insufficient attention, the growth is uneven and backward and rats and birds are troublesome. On one such at Labis an average yield of 250 gantangs per acre is said to be obtained.

As part of the instruction duties to be undertaken, as stated above, by the inspecting officers, the following lines of work for improving the yields of padi have been carried out in co-operation with the Economic Botanist:—

(i) Experiment Station. An experiment station, for selecting pure lines of good local varieties of padi and for testing the suitability to Malacca of certain pure strains from the Krian Experiment Station at Titi Serong was opened on Crown land in the mukim of Klebang Besar, about 6 miles from Malacca, during July. Unforeseen circumstances over which this department had no control resulted in lack of facilities for regulating the water supply, in consequence of which much of the present year's work has been lost. The work will be continued next year.

(ii) Testing stations have been established at Permatang Toh Gelam in Province Wellesley and at Talang bendang just outside Kuala Kangsar, in order to test the suitability of certain pure strains of padi from the Krian Experiment Station to local conditions represented by these stations. If satisfactory results are obtained, these stations will serve also as useful demonstration plots. The padi at both gave excellent promise at the close of the year. The yields of the different strains in the coming harvest will be compared with those from the surrounding bendangs as well as with one another. It is intended to establish more of these testing stations during the coming year.

(iii) Distribution of selected seed. During 1921 a certain quantity of seed of selected pure strains of padi was distributed, especially in Perak. This seed has yielded well in many instances and is appreciated by the Malays. As an example, it is interesting to note that in three mukims of Kuala Kangsar district 7 gantangs of seed were distributed in 1921. In 1922 40 persons in these mukims obtained seed from the cultivators who planted it in 1921 and planted up a total of 163½ gantangs. The Penghulu, Chegor Galah, planted his bendang at Jawang solely with the departmental selected strains in 1922.

The distribution of this seed was continued in Perak in 1922 and supplies were also distributed in Penang, Province Wellesley, Malacca and to a small extent in Pahang East. Records of the cultivators receiving this seed have been kept and the yields from their plots will be compared with those of the mixed strains on surrounding bendangs, in order to determine which of the selected varieties are best suited to local conditions in the different districts.

The Assistant Agricultural Inspector, Perak North, intends to start experiments in the coming year to test the effect of growing leguminous crops between seasons in order to improve the yield of padi on certain bendangs on which the yields have decreased in recent years.

The same officer is starting experiments to ascertain if dredged mining land can be restored to good padi land in the course of 3 or 4 years by growing a succession of suitable leguminous green manures on it. This line of work is of considerable importance. Dredges can now lay out the land dredged, evenly, and with a suitable top layer of slime which, with a proper admixture of humus from decaying vegetable matter, should make a suitable padi soil. If a satisfactory method of restoring fertility can be found, it would be possible to dredge the tin from bendangs and restore the bendang in good condition after a few years, and also to turn land at present purely waste into padi land.

Fertilisers. The Assistant Agricultural Inspector, Penang and Province Wellesley suggests that great advantages would be obtained by the opening of Government fertiliser supply stations in each district of the Settlement, at which the rayat could obtain the best and most suitable fertilisers at cost price. The manures at present

used by Malays and obtained from the local Chinese shops are often bad in quality and very high in price. A sample of one of these was sent to the Agricultural Chemist and his report shows that the price charged by the vendor was approximately five times more than the real manurial value.

At present, however, no definite data are available as to the most suitable fertilisers and preliminary experimental work must be done. This will be commenced in the coming year.

Preliminary work in preparing the Experiment Station in Malacca indicated that tractors might be employed successfully and economically in preparing certain types of padi land for planting, and their use at harvest also seems possible. Further experiments on the use of tractors for padi cultivation are proposed for 1923. If tractors can be used successfully at a reasonable cost, their use would overcome the difficulties that arise when numbers of buffaloes in any district die from rinderpest.

4. *Fruits.*

The fruit season in the middle of the year was good in most parts of the Peninsula except in Pahang West where the crop was below the average. Durians, mangosteens and rambutans were especially plentiful.

Tan Kah Khee has opened a pineapple canning factory in Klang which has been operating for the last 3 months of the year. The fruit is grown in Kuala Langat, Klang and Kuala Selangor districts. The price of fruit at the door of the factory has varied from 5 to 2½ cents each.

In Johore two factories near Johore Bahru have been improved and a third has been opened, while another small factory is operating at Kota Tinggi. The area under pineapples in Johore is steadily increasing. The whole of the cultivation and canning is in the hands of Chinese. The average for fruit is from 3 to 5 cents each. The daily output of the two larger factories near Johore averages 10,000 tins each, the Klang factory produces 20,000 tins of 1½ lb. daily.

A small factory was opened in Province Wellesley in August, but had to close down before the end of the year on account of the fall in the price of tinned pineapples from $10.60 to $5.50 per case.

It is estimated that about 5,000,000 fresh fruit are exported from Johore to Singapore annually.

In general, attention to grading the fruit, as is done in the Klang factory, would result in improved prices.

Notes have been made on the varieties of pineapples, more especially those used for canning, and on the methods used for growing them. It is peculiar that, while pineapples do well on poor, washed soils in southern Johore, they also do well on peat in Selangor.

A collection of the varieties of banana growing in this country was completed for Serdang Government Plantation in the first quarter of the year.

5. *Other Crops.*

Roselle. This crop has been grown successfully on a considerable scale on one estate in Perak. On most other estates where it has been tried, it has only been grown on small areas experimentally or for seed purposes. There is now a definite market for the fibre. Its principal use locally is for the manufacture of rope.

On small holdings its suitability is still uncertain. Four demonstration plots have been established in Perak and two in Selangor on small holdings, but the results so far have been doubtful. One plot in Selangor was doing well at the end of the year. The two plots in Selangor were also planted with kapok, but this plant has not developed well from seed sown at stake. Further work with these two plants on small holdings is contemplated.

Tapioca is still grown on a considerable scale in Johore and to a less extent in Province Wellesley, elsewhere there are few large areas of it.

Interest has also been shown in reviving the cultivation of coffee and in the possibilities of limes, tuba root, tea and cotton as new crops. On one Chinese owned estate, the tung oil or Chinese wood oil plant *Aleurites fordii, Hemsl,* is being tried, and one or two European owned estates have planted up areas of candle-nut, *Aleurites triloba, Forst.*

African Oil Palm. This crop gives promise of proving a commercial success on one estate in Selangor. There are a few young estates that have been planted up in the last two or three years, while further planting will probably be undertaken during the coming year in Perak, Selangor and Pahang.

The production of cloves and nutmegs in Penang island is declining, though the quality of the produce is good. Possibly steps could be taken to revive the cultivation of the crops. The present growers are almost entirely Chinese owners of small areas.

X. General Notes.

1. *Instructional.*

In the first quarter of the year officers of the division were much occupied with work in preparation for and at the Malay-Borneo Exhibition.

In November a Conference of Malay Officers of the Department was held in Kuala Lumpur. There were several interesting papers on Co-operation and a visit was paid to the Experimental Plantation at Serdang.

The usual lecture courses for Malay officers in training were continued during the year and departmental examinations were also held to qualify more senior officers for promotion.

The reports of the work of the Inspection Staff for the first three quarters of 1922 have appeared in the *Malayan Agricultural Journal* Vol. X. Nos. 4, p. 106 ; 7, p. 195 ; and 10, 11, 12, p. 264.

A summary of the Regulations Controlling the Importation of Plants into the Straits Settlements, the Federated Malay States and Johore was prepared by the Chief Agricultural Inspector and published in the Malayan Agricultural Journal Vol. X. p. 228.

Other branches of instructional work have already been mentioned under different headings.

2. Legislation.

The abolition of the appointment of Director of Agriculture and the substitution of that of Secretary for Agriculture in February 1922 necessitated amendments of the Agricultural Pests Enactment No. 13 of 1913 in the Federated Malay States and of Ordinance No. 166 (Agricultural Pests) in the Colony.

At the same time it was considered desirable to abolish the special procedure laid down for the black beetle and red stripe weevil of coconuts and to bring them under the general sections of the Enactment and Ordinance. In the Colony this was all done in Ordinance No. 166 (Agricultural Pests) Amendment Ordinance, 1922, published as Notification No. 1093 in the Straits Settlements Government Gazette of June, 30th, 1922.

In the Federated Malay States the first correction was made in the Agricultural Pests Enactment, 1913 Amendment Enactment No, 9 of 1922, published as Notification No. 4085 in the Federated Malay States Government Gazette of July 14, 1222. The second alteration was made in The Agricultural Pests Enactment, 1913. Amendment (No. 2), No. 27 of 1922, published in the Federated Malay States Government Gazette, Notification No. 7871, of December 20th 1922.

A rule regarding the importation of cotton plants into the Colony of the Straits Settlements was published as Notification No. 1777 in the Government Gazette of October 27, 1922. A similar rule in the Federated Malay States is awaiting consideration of a complete revision of the rules regarding the importation of plants into the Peninsula from countries outside it.

The Destructive Insects and Pests Order of 1922 in England and Wales, revoking the Order of 1921, came into force on July 1st, 1922,

and a similar order in Scotland came into force on August 1st, 1922. The procedure now necessary when plants are exported to England and Wales or to Scotland is given in Notification No. 2015 in the Straits Settlements Government Gazette of December 1st, 1922. The procedure necessary under the 1921 Order was published in the Federated Malay States Government Gazette, as Notification No. 2060 of March 24, 1922. The necessary revision of this Notification was expected to appear early in January 1923.

ANNUAL REPORT OF THE ECONOMIC BOTANIST FOR 1922.

By H. W. Jack.

Staff.—H. W. Jack, Economic Botanist, W. N. Sands, Assistant Economic Botanist.

Padi.—Experimental work with rice continued to be the main research carried on by this Division and the first five months of the year involved frequent and prolonged visits to the Titi Serong Experiment Station in Krian. The first three months were occupied with the checking, in the field, of the agricultural and botanical characters of all the strains of padi under trial and in preparations for the harvesting which did not begin until the last week of March and finished at the end of May. The Krian crop of 13,906,130 gantangs was less than the average of the last twelve years by 83,000 gantangs. The crop had a " bumper " appearance until some 2 or 3 weeks prior to harvest when showery weather caused a considerable amount of lodging and germination of grain. The prolonged drought which necessitated a postponement of cultural operations at the beginning of the season, was the source of the trouble, for in the period February-March which as usual proved to be the dry period suitable for harvesting, the padi was very immature and the rainy weather began on 18th March and continued right up to the end of May, thus damaging the harvest materially. Had it been possible to perform cultural operations up to scheduled time the crop at harvest would have been higher by at least one million gantangs.

The Bukit Merah reservoir requires to be cleared of the heavy growth of weeds etc. which is rapidly diminishing its water capacity, with the result that a long spell of dry weather, which is of frequent occurrence between May and August, usually means a delay in beginning cultivation. This delay has the effect of postponing harvest so that it misses the dry month of February for which it is timed and the crop suffers in consequence when the short rainy season, beginning at the end of March, damages the crop and renders harvesting operations more difficult and more expensive. Though the crop in 1922 was little below the average, from the experimental aspect, the harvest was a bad one because the rains damaged the different pure strains under trial to a different degree according to the actual weather prevailing during the cutting and drying of each pure strain.

During last season (1921-22) 120 pure strains representing six varieties, and being the best selections from an original collection of 1,300 strains, were tested at Titi Serong Experiment Station for yielding ability. The mean yield of 120 pure strains was over 20% higher than the mean yield derived from unselected seed.

For the present season's tests the number of pure strains has been reduced, by elimination of the least promising, to 67 strains

which were planted up during the last quarter. In addition to these 67 strains, 10 pure strains, previously grown for four years amongst the variety tests were selected for trial of yielding ability this season, as strains of probable utility in certain districts of Malaya. Each of the above 77 pure strains has been planted out in plots of eighty plants, duplicated four times and suitably chessboarded. This planting arrangement has been proved to give averages of sufficient experimental accuracy for the purpose of selection for production of grain.

The best 26 of these strains have also been multiplied in half-acre plots, in anticipation of their distribution for seed purposes, and for testing in other districts should they prove equal to expectations. After the harvest of 1921, small lots (2-3 gantangs) f seed of some of these 26 pure strains were sent to reliable planters in several districts for tests under local conditions and though little could be done towards following up the results of this preliminary distribution in the 1922 harvest, it is most gratifying to find that in most cases these small seed lots are reported to have produced better crops than those derived from unselected local seed.

In several areas it has been found that the entire crop derived from these small seed lots has been saved for seed and distributed amongst neighbouring cultivators without any encouragement from officers of the Department and even without their knowledge. For example, a cultivator in bendang Ulu Papan in the Kuala Kangsar district planted up one-fifth of an acre with Departmentally selected seed and the entire crop of 78 gantangs was distributed amongst 17 neighbouring cultivators, whose lands, fully planted, were recently inspected by the writer.

This natural distribution of selected seed speaks for itself. Through the Inspection Division it is hoped that a large number of small tests of selected seed will be carried out in 1923, the idea being that if the sample lots of seed prove better than local seed, natural distribution of selected seed will take place. These small tests are chiefly confined to the larger padi areas this season, including Malacca, Perak, Province Wellesley and Kedah, but it is intended to extend them to other padi districts in 1923. Reports on the growing crops in the districts mentioned are hopeful, especially in Perak and Malacca though in the latter territory much damage has been done by severe flooding.

Experiments with small power rice mills were carried out with a view to recommending mills for estate rice milling in order to encourage local production and to diminish the beri-beri menace.

Rubber.—Little attention is given to this crop because of shortage of staff, but monthly records of individual tree yields have been kept on 800 mature trees for the purposes of investigation into the variation in yield, periodic yields, morphological correlations with yield and of finding high yielding parent trees for ultimate seed selection; for experimental vegetative propagation by different methods and for the study of the genetics of Hevea.

Coconuts.—Monthly records of individual tree yields of fruit have been maintained on 450 trees in connection with a study of individual tree variation in yield, the establishment of some relationship between type of tree and yielding ability, the examination of periodicity of yield, the search for good parent trees for further genetical research and the comparison of their yielding abilities for future use as seed producers. In this latter connection approximately seventy lots of seedlings, each lot being the progeny of a single tree, have been planted at Sapintas. A study is also being made of the botanical and agricultural characters of various types indigenous and introduced, and of the methods of pollination and phases of flowering of the main types.

Cinchona.—The Assistant Economic Botanist (Mr. W. N. Sands) spent three weeks in Java early in the year, investigating the methods of cultivation and manufacture of quinine employed by the Dutch with a view to decide the possibility of establishing this useful industry in Malaya. He also visited all the accessible hills in the Peninsula to report on their suitability for the cultivation of "cinchona." Cameron's Highlands, on which Mr. Sands spent 3 weeks, were found to be admirably suited to the needs of "cinchona," none of the other hills being of sufficient elevation or affording suitably undulating land on a large enough scale.

Cotton.—Fourteen types of cotton were grown under pure line conditions on a small scale and several types were found to produce a crop equal to the average obtainable in the West Indies. This crop can be grown on the lighter soils of Malaya, its success depending on good cultivation, close expert supervision and systematised pest control. Moderate rains are essential for the germination of the seed and dry weather is advantageous when the crop is being harvested.

Drugs.—The study of native medicinal plants was initiated during the year, partly at the instigation of the medical authorities, and a collection of fifty-seven different plants was established locally on a small scale. Several of these medicinal plants give promise of possible economic utility and samples have been delivered to the Agricultural Chemist for analysis and report.

Botanical.—Over 120 indigenous plants, economic and ornamental, were identified for members of the Department and outside enquirers during the year. A preliminary investigation of characters of the so-called varieties of the nipah palm was started.

A study of the aquatic flora of the rice fields was initiated partly in connection with rice work and the reclamation of rice land but also partly at the request of the Medical Entomologist.

Sugar-cane.—Twelve types of sugar-cane were selected and handed to the Agriculturist. They now cover some 40 acres at Serdang and some types have given high yields.

Malaya-Borneo Exhibition.—This Division was responsible for exhibits of (*a*) padi and rice and instruments used in padi cultivation,

(*b*) collection of types of coconuts, (*c*) collection of types of sugar-cane, and (*d*) collection of types of nipah palm. The officers of the Division acted as judges of the padi and rice at the Agricultural Show.

Publications.—The following articles were published by the Division during the year :—

(1) Rice Milling for Estates.

(2) Notes on Dwarf Coconuts.

(3) Selection in "Hevea."

(4) Selection in Coconuts.

(5) Report on Java Quinine Industry.

(6) Improvement of Cereals.

(7) Notes on the Brazil Nut in Malaya.

(8) Bud Selection in "Hevea."

(9) Agricultural Possibilities of Cameron's Highlands.

(10) Long Staple Cotton Experiments in Malaya.

(11) Memorandum on Chicle Gum.

ANNUAL REPORT OF THE MYCOLOGIST FOR 1922.

By A. Sharples.

Staff.—Mr. A. Sharples, Mycologist. Mr. A. Thompson and Mr. F. R. Mason, Assistant Mycologists reported for duty, the former on 21st December 1921, and the latter on 6th March 1922. With this assistance I have been able to devote some considerable time to minor crops which was impossible previously.

General.—A feature of the year's work has been the number of queries relating to diseases on crops other than Rubber and Coconuts. Diseased specimens of Roselle, Bananas, *Hibiscus rosa-sinensis*, Tuba, etc., etc., cover crops such as *Mimosa invisa*, *Tephresia candida*, have all been dealt with. Some time has been spent on diseases of Arghan Fibre.

The long-standing investigations on Rubber, Coconuts, and Oil Palms have been carried forward. The following details will indicate the progress made.

Rubber Root diseases.—The importance of root diseases in the future of Malayan plantations was emphasised many years ago by the Department and as time goes on it becomes more evident that many old properties will lose considerable acreages owing to neglect of this question. The prevalence of Root diseases in Malaya touches closely upon future progress when development along lines designed to give increased yields are in vogue. Considerable effort has always been devoted to obtaining more definite evidence on these difficult questions. During the last three years the problem of Brown Root disease has been under consideration.

Brown Root disease.—Up to 1917 the cause of this disease, known as attacking most tropical cultivations, was considered to be *Hymenochatae noxia* (Berk). In 1917 Petch found numerous fructifications of *Fomes Lamaoensis* (Murr) in association with roots of Tea and Rubber attacked by Brown Root disease. He now considers this fungus to be the cause of Brown Root disease.

Brown Root disease on Malayan and Ceylon Rubber and on Camphor.—During 1920 a bad attack of Brown Root disease in a Malayan Estate was encountered. Cultures were obtained from these diseased roots. Specimens of Brown Root disease on Rubber from Ceylon were sent for and successful cultures set up from these specimens. The fungi, in culture, were totally different in appearance. To try to find an explanation for this discrepancy, roots of camphor suffering from Brown Root disease were obtained and cultures made from them. These cultures were again different from the other two. Whilst differing entirely in cultural characteristics, their growth peculiarities on the rubber wood blocks in the culture flasks were

exactly similar. The main point in the investigation is that substantial evidence has been obtained to support the view that different fungi are responsible for the symptoms characterising Brown Root disease on different crops. This work makes it necessary to regard Brown Root disease from a very different angle. A preliminary article on this work was written up for the Malayan Agricultural Journal.

Thinning-out of Rubber in relation to root diseases etc.—Considerable attention has been devoted to this matter in view of the tendency towards the possibility of maintaining yield figures with fewer trees per acre by increasing individual yields and so reducing costs of production. Up-to-date, the experiments are very satisfactory and the response of mature trees, in Malaya, towards better spacing conditions is reflected in the maintenance of yields per acre. An editorial giving details of observations on an inland estate was written up for the Malayan Agricultural Journal. Figures from other experimental blocks on a coast land estate are obtained monthly and provide interesting results. This line of work should provide very definite evidence for future guidance as to estate policy.

Brown Bast.—This interesting disease has been under constant experimental observation since early 1920. Many interesting facts have come to light and many unrecorded features have been demonstrated. The more important points as now established may be mentioned :

(*a*) No evidence of organic cause has been obtained.

(*b*) Positive evidence has been obtained to show that increasing the time between each tapping period, materially reduces the number of Brown Bast cases, i,e. Alternate Daily tapping on the same length of cut shows a far lower number of Brown Bast cases than Daily Tapping.

(*c*) The relation between yields, tapping Daily, Alternate Daily, and Every Third Day, obvious on $\frac{1}{4}$ and $\frac{1}{2}$ cuts, breaks down when longer cuts are used.

(*d*) That in certain months of the year Brown Bast development is practically nil and that the inception of Brown Bast appears to depend on "Trigger action,"; there is a sudden burst during certain months. This feature has been marked over the last three years on more than 20 plots.

(*e*) In one plot of fifty trees immune for 11 months very definite evidence has been provided that the sudden appearance of Brown Bast was directly correlated with a sudden increase in yield.

(*f*) That Brown Bast extension on individual trees can be prevented by a deep cut to the wood or by a sufficiently wide bridge of renewing bark. This latter is important because of the weight Kouchenius attaches to his observations on isolations by deep cuts which form the basis of his theory.

(*g*) That Brown Bast in its downward extention is in the great majority of cases greatly impeded, or even stopped at the line marking two panels of different ages of bark.

(*h*) That bad yielders are often attacked to the same extent as good yielders.

(*i*) That Brown Bast is an exhaustion phenomenon ; accepting this as a basis, laboratory and field observations previously contradictory, can be brought into line.

These points when elaborated and supported by the figures obtained will be seen to have great significance with regard to future development of Malayan Plantations.

Mouldy Rot.—An effective control for Mouldy Rot on European Estates has been demonstrated over the last two years at a cost of $1.26 per acre per annum. The demonstration provided ample proof that *Agrisol* is a reliable fungicide in the control of Mouldy Rot and the results provide substantial evidence for the view that this disease can be controlled at a low cost and so need not be considered as a factor permanently influencing the policy of affected plantations. Owing to the peculiar spore development there is little chance of eradicating this disease, and its appearance in different parts of Malaya may be expected. It is spreading gradually all round the badly infected districts and a sudden appearance in Perak has been confirmed. Unless neglected, there is no cause for alarm.

Two articles dealing with the *Agrisol* experiments were published in the Agricultural Bulletin F.M.S.

The above deals with the main lines on Rubber, but other interesting matters which might be mentioned shortly are :—

(*a*) *Slugs.*—A bad attack of defoliation owing to slugs.

(*b*) *Top-Canker.*—The appearance of Top-Canker supposed to be due to a Phytopthora species. We were not able to confirm this.

(*c*) *Leaf-Fall.*—A case of leaf-fall much resembling that described from India as caused by *Phytopthora meadii.*

Some considerable time was spent on this, but no Phycomycetous hyphae could be demonstrated and no cultures of *Phytopthora* were obtained.

(*d*) *Helminthosporium* (*Nov. sp.*)—A new species of Helminthosporium was obtained capable of growing on young rubber plants causing slight damage.

Phytopthora diseases.—The investigation of the fungi of this genus is of great future importance. At present, much confusion surrounds the various species of *Phytopthora* considered as dangerous to Rubber, Coconuts and Oil Palms. "Black Stripe", "Top-Canker",

Leaf-fall and Pod-Rot of Rubber, Bud-Rot of Coconut and Oil Palms, Nut-fall of Coconuts all come up for consideration in this investigation. Owing to pressure of present work, little progress can be made on these lines.

Coconut and Oil Palms.

Bud-Rot.—In my annual report for 1921 I referred to experimental inoculation work carried out at Castleton Estate, Teluk Anson. The publication of the work as a special bulletin has been held up owing to lack of funds, but the conclusions arrived at have been applied to Oil Palms suffering from Bud-Rot. The soundness of the conclusion has been amply verified and there are numerous cases of Oil Palms suffering from Bud Rot being successfully treated and growing into healthy palms again. In the case of tall growing Coconut Palms there is little chance of successful treatment.

During the year many visits to investigate palms *in situ* suffering from "Bud-Rot" have been made. In several cases the clear connection with insect attacks have been demonstrated. Evidence is being steadily collected to show that, in Malaya, Bud-Rot is a secondary symptom, following on insect attacks and is not to be confused with epidemic Bud-Rot caused by a species of the genus *Phytopthora.*

Stem-Bleeding disease.—This disease has been investigated in Ceylon and at one time was expected to cause much damage in that country. The causal fungus was named as *Thielaviopsis ethaceticus* (Went). During the last 18 months several estates have been visited showing bleeding of the Coconut Palm stems. The bleeding has been associated with a salmon-pink discoloration of the trunk, white ants, and the presence of *Thielaviopsis ethaceticus.* Careful comparative observations have led to the conclusion that the salmon-pink discoloration is the important symptom and that the above mentioned fungus and White Ants are secondary symptoms. Inoculations with pure cultures of the fungus *Thielaviopsis ethaceticus* were unsuccessful. I suspect that the disease is to be traced to infection through the roots and then very slowly progresses up through the tissues of the trunk. As the disease takes a long time to develop there is no urgency in the investigation and this is deferred to more convenient times.

Black Spot disease on petioles and leaf stalks.—A recent investigation of a mature palm which appeared from a casual observation to be suffering severely from a bad attack of *Pestalozzia palmarum* on petioles and leaf stalks showed that this fungus was not prominent on or in the neighbourhood of the spots. The presence of an organism related to *Spongospora* species was demonstrated in the affected tissues. These lowly organisms are difficult to investigate but I hope to spend some time at Kew dealing with this particular organism when I take my leave next July.

Nut-Fall of Coconuts. (*a*) *Mature nuts.*—Falling of mature nuts have been under observation. There appear to be many varying symptoms and up-to-date I cannot report much progress. Petch says a *Phytopthora* sp. is the probable cause in Ceylon but I have not been able to confirm this.

(*b*) *Immature nuts.*—Work on this problem has been undertaken in conjunction with the Government Entomologist.

Collapse of Central Leaves in young Oil Palms.—A well marked feature on young Oil Palms *i.e.*, up to 2 years old, is a kind of incipient "Bud-Rot." The disease commences with the collapse of the 3rd or 4th leaf from the centre. Later the outer leaves collapse but the central leaf remains stiff and healthy. The central leaves continue healthy and finally a set of new healthy leaves is produced surrounded by the collapsed outer leaves. This peculiarity is quite common and is easily followed but the explanation is more difficult. No organic cause has as yet been demonstrated but the suggested explanation is a form of incipient "Bud-Rot" in which, owing to the rapid growth of the central leaves of the "Oil palm," the diseased area is carried away from the central portions.

Leaf Spot on Oil Palms.—Some time has been spent in investigating the fungi causing spotting of the leaves of Oil Palms.

Other Crops. Roselle Fibre. Eel-Worms on Roselle Fibre.—As mentioned above, considerable interest has been show in subsidiary crops. Roselle fibre, the product of *Hibiscus Sabdariffa* var *altisimma* has attracted considerable public attention. From the point of view of diseases this crop varies considerably in so far that a good growth may be obtained as a first crop but the subsequent crops may be rather discouraging. The chief cause of trouble seems to be Eel-worms which kill large patches. A Bacterial disease of the vascular bundles has been noted and also diseased roots showing Phycomycetous hypae. These will receive future consideration.

Argan Fibre.—A visit was made early in the year to the Arghan Fibre Company's Nursery at Rompin to advise on a disease, presumably Bacterial, which was spreading and causing some uneasiness. The matter was taken in hand and the disease successfully put under control. Recently a new collar disease has appeared, probably owing to the extremely wet condition of the soil of the Nursery. The prominent fungus is *Thielaviopsis ethaceticus*, which is common on pineapples, a relative of the Arghan plant.

Tobacco.—Dr. Samuels, Medical Superintendent at Tanjong Rambutan, who is keenly interested in subsidiary crops has sent in specimens of diseased Tobacco and Banana plants. We were able to show how the tobacco disease could be tackled successfully, healthy leaves and seeds being obtained from the diseased specimens sent in.

Final.—Many other crops have come up for consideration, and general enquiries answered. Wither-tip of limes, diseased plants of Tuba Root, fungi on Cover crops such as Centrosema, Tephrosia, etc., *Graphiola phoenicis* on Date Palms, fasciations on Rubber, diseased Cacao Pods, diseased plants of Sisal Hemp have all been under observation.

We have been in communication with several prominent Mycologists and cultures of 10 different strains of *Diplodia* sp. were prepared by Mr. Thompson and sent to Dr. Butler of the Imperial Bureau of Mycology, for transfer to Dr. Shears in America. Cultures of *Phytopthora faberi*, *Phytopthora palmarum* and the *Phytopthora* species causing Black Stripe disease of Rubber were despatched to Prof. O. A. Reinking, for investigation in the University of Wisconsim.

The preparation of specimens for the Malaya-Borneo exhibition took up a good part of the time during the first quarter.

At the request of the Rajah of Sarawak I spent from the 13th of September to October 9th in dealing with a serious outbreak of disease on Pepper Vines in Sarawak. During my visit I was able to spot the cause of the trouble and reported that I considered the disease a preventible one.

During the year the Seychelles Islands administration also asked for aid and advice regarding a disease of Coconuts which appeared to be spreading rapidly.

ANNUAL REPORT OF THE GOVERNMENT ENTOMOLOGIST FOR 1922.

By

G. H. Corbett.

1. *Staff.*—The Government Entomologist was in charge of the section throughout the year.

Mr. W. Malcolm Miller commenced duties as Acting Assistant Entomologist on the 1st January, 1922.

Mr. B. A. R. Gater reported for duty on the 18th, December.

2. *Publications.* No special bulletins have been published but manuscripts are ready for publication concerning the life history, habits and control of :—

(i) *Rhynchophorus schach*, Oliv. "Red Stripe" Weevil of Coconut.

(ii) *Plesispa reichei*, Chap. The two-coloured coconut leaf beetle.

(iii) *Podops coarctata*, Fab. "Kutu bruang"—a sucking bug of padi.

The following entomological articles have appeared in the Malayan Agricultural Journal :—

(i) Entomological Jottings, February.

(ii) The Rubber Flower Geometrid (*Hemithea costipunctata*, Moore) April.

(iii) Preliminary Note on the "Lesser" Coconut Spike Moth, May.

(iv) Moths from Coconut Spikes, July.

An article on "*Insect Pests*" appeared in the Malayan Agricultural Handbook for the Malaya-Borneo Exhibition.

3. *Investigations.*—During the past year special attention has been paid to Pests of Coconuts and Padi, and considerable information has been obtained concerning their life histories and control. Insect enemies of other plants have been observed and information with regard to their habits has been recorded for future reference.

Insects of Coconuts.

Oryctes rhinoceros, Linn. The Black or Rhinoceros Beetle.

The investigation of this insect has been in progress during the whole of this year and will be completed shortly.

The minimum time from the hatching of the egg to the emergence of the adult from the cocoon found up to the present is 149 days.

Experiments under natural conditions will have to be undertaken before this figure can be definitely stated to be the minimum for the life cycle.

Rhynchophorus schach, Oliv. "Red Stripe" Weevil.

A manuscript concerning *Rhynchophorus schach*, Oliv. has been prepared for publication. A brief summary of the results obtained during the investigation of this insect is given below.

1. The palm weevil attacking coconuts in Malaya is the "Red Stripe" Weevil, *Rhynchophorus schach*, Oliv.

2. More damage to individual coconut palms is done by this weevil than by the Black or Rhinoceros beetle (*Oryctes rhinoceros*) or any other insect. The grubs or larvae tunnel in the tissues of the plant, and one such may cause its death by eating into the growing point.

3. Most palms are attacked as well as the coconut, and hence provide alternative food plants.

4. A coconut palm attacked in the crown is detected by the central shoots falling down and in trunk infections by gummy exudations and discarded fibre projecting from the holes.

5. Eggs are not laid in undamaged tissue, but advantage is taken of damage caused by the borings of Black or Rhinoceros beetles, and probably other borers, by "White Ants," (*Coptotermes gestroi*), and by man.

6. Larvae may be found in any part of a palm. After eight years of age the damage is generally confined to the upper portions of the palm. In palms of fifteen years of age and over, larvae are rarely found elsewhere than at the bases of the leaf petioles, the crown, and about one metre below the last whorl of leaves.

7. Female weevils are capable of laying up to 832 eggs, and once laying is commenced it is continuous. The eggs are laid in cavities drilled in the damaged tissue by the rostrum of the female. The holes are then closed by pinkish plugs of definite structure.

8. The maximum observed life of a female weevil was 116 days that of a male 107 days.

9. The egg hatches in three days and the resulting larva feeds for a minimum of 59 days. It feeds on the softer tissues only, the fibres being pushed to one side and then forced to the rear of the gallery. A cocoon of fibres is formed when the larva is full grown, and the insect remains in this for not less than 25 days. There are inactive larval and adult stages before and after pupation in the cocoon, during the latter of which the weevil becomes sexually mature.

The minimum time taken to complete the life history, egg to adult, was 87 days.

Eggs may be laid by the female on the day after emergence from the cocoon.

The larvae moult 16-20 times during their life.

10. It was found that grubs can live and complete their life cycle and that adults can emerge from logs buried more than 3 feet under the ground. Eggs were not laid in wood covered by one inch of sand.

11. Preventive measures consist in destroying all possible breeding places of *Oryctes rhinoceros*, and generally preventing the trees from being damaged. All borings caused by the Rhinoceros beetle should receive immediate attention.

Leaf petioles and other parts of the palms should not be pulled off or broken, and all wounds should be tarred at least twice. Toddy steps should not be cut more than one inch deep, and not at all near the crown. Experiments have shown that the newly emerged grubs are incapable of eating through the hard layer of vascular bundles but can eat their way down the leaf petiole into the trunk. Remedial measures consist in burning all palms suffering from crown infection, and all palm refuse. This should be done within three months if no grubs are seen, whilst if they are present it should be done as soon as possible.

12. Trapping with split logs of various palms is not recommended unless large numbers of weevils are present.

Burying logs is inadvisable, because they will form breeding places if any eggs or grubs are in them at the time of burial. Buried logs may be exposed by wash and may form sources of infection.

Plesispa reichei, Chap. [*Hispinae*].

A manuscript on the two-coloured coconut leaf beetle, *Plesispa reichei*, Chap., has been forwarded for publication.

A summary of the work is given below:—

1. This insect is essentially a pest of seedlings in the nursery and young coconut palms in the field up to two or three years of age.

2. It has been found on older trees, but these trees appear to be growing in unsuitable conditions or suffering from previous injury.

3. The eggs which are brown in colour are laid on the leaves.

4. The grubs and adults feed on the surface of the partially folded up leaves.

5. When full grown the grubs pupate on the leaves.

6. The beetles are about ¼ inch in length without the antennae, the wing covers are black, and the head and thorax are yellowish brown in colour.

7. The larva and pupa are yellowish in colour about ¼ inch in length, have lateral projections, and their anal segments terminate in two caliper-like hooks.

8. The eggs hatch in about 7-10 days, generally in about 7 days; the larval stage lasts 30-38 days, usually about 33 days; the pupal stage lasts from 6-11 days, generally about 7 days.

9. Both male and female beetles may live a long time. The maximum length of time found for the life of the male is 9 months and the female about 9½ months.

10. The largest number of eggs found deposited by a female was 112 in 249 days.

11. Nurseries should not be made under coconut trees but should be prepared under other trees or in a shady place.

12. Eggs, grubs, pupae, and adults should be collected from the seedlings in the nurseries. If the stages of this insect are not collected by hand, the central portions of the plant should be well sprayed with Lead Arsenate.

13. Previous to supplying or planting young seedlings should be immersed in a solution of Lead Arsenate at the rate of 4 lbs. to 100 gallons of water. If they have been subjected to heavy rains prior to planting out, and it is considered necessary, they should be immersed again, and after planting out sprayed to kill the larvae which have in the meantime hatched from the eggs.

Batrachedra arenosella. Gosmopterygidae. Walk. "Lesser" Coconut Spike Moth.

During the year 1922, *Batrachedra arenosella*—an unrecorded insect on coconuts—was found in Malaya.

This insect, which causes injury to both male and female flowers of the coconut spike before the spathe opens, was first observed in Perak and later in Malacca, Selangor, and Negri Sembilan. It is probably distributed throughout the Peninsula.

Batrachedra arenosella would appear to be the principal insect injurious to the coconut spike and probably the most serious in reducing the yield of coconuts over large areas.

Unopened spikes forwarded for examination have shown 68 per cent of the female flowers damaged by the caterpillars of this moth.

Unopened spikes, cut from several palms bearing no nuts and from palms considered to be bearing well, have on opening revealed the presence of the caterpillars of *Batrachedra arenosella*. From

both classes of palms the yield might have been greater if caterpillars had not been present.

Frequently when the spathes are cut open injury is not observed, but by taking the inflorescence out of the spathe damage confined essentially to the inner surfaces of the flowers is noticed.

The damage is chiefly seen on the flowers at the basal half of the spike but the marks showing where the caterpillars have entered through the spathe are generally found at the apical half.

The present observations have shown that the eggs of this insect are laid on the outside of the spathe generally between the grooves where the tissue is softer than at the surface.

The egg is very small and when about to hatch the caterpillar may be seen doubled up inside it. The eggs hatch in from two to three days and the caterpillars, having bored through the spathe, feed upon the male and female flowers. The larval stage lasts from 5-8 days. When full grown the caterpillars pupate in white elongated silken cocoons generally at the base of the main flower stalks. The pupal stage lasts from 6-8 days.

In field observations on coconut palms carrying three unopened spikes, the youngest spike has not been noticed to be attacked, the middle spike generally shows slight feeding marks and spots on the inside of the spathe, whilst the oldest spike generally contains caterpillars, cocoons, and occasionally moths. Cocoons with their pupae are, however, mostly in evidence.

The spikes of palms of six years and upwards have shown the presence of caterpillars. Spikes of palms below that age although adjoining areas where this insect was present were not observed to be attacked.

Control.—Experiments are being conducted in order to find out a satisfactory control for this insect. They consist in spraying the spikes with poisonous substances, painting the spikes with poisonous baits and deterrents, and light traps.

Tirathaba sp. near *trichogramma*, Meyr. The "Greater" Coconut Spike Moth. [*Pyralidae*].

Observations concerning this insect, which is generally distributed throughout Malaya, are being made in conjunction with *Batrachedra arenosella*, Walk.

This moth lays its eggs on the opened flowers of the spike generally where the buds overlap one another.

Preliminary breeding work shows that the minimum length of time from egg to adult is 28 days and the maximum 43 days.

The caterpillars of this moth usually feed on the male flowers. They are active and form a gallery of excrement through which they advance or retire when disturbed.

Pupation takes place on the spike or on the spathe or at the base of the spike where, owing to the fallen flowers collecting there, the larvae are able to reach maturity.

The control for this insect should, until more definite information has been obtained, take the form of freeing the palms from all badly attacked spikes and all accumulated fallen flowers at the base of the spike.

Erecthias flavistriata, Lyonetiadae, Wals. and *Pyroderces ptilodelta, Cosmopterygidae*, Meyr.

The caterpillars of both these moths feed on the opened coconut spike, but their economic importance has not been established. It is probable, since they have been obtained from old spikes that they feed on the decayed portions of the coconut spike.

Insects of Padi.

Leptocorisa varicornis, Fb. The Padi "Fly."

This padi bug, *Leptocorisa varicornis*, known locally as "Pianggang," is forming one of the principal entomological investigations of insects injurious to padi.

The nymphs and adults live throughout the year on the inflorescences of wild grasses by sucking the sap from the developing seeds. The adult attracts attention when it migrates to the padi as the grain begins to form.

The inflorescences of the following wild grasses have been found to give suitable nourishment for the development of this insect from the hatching of the egg to the adult condition :—

1. *Panicum colonum*, Linn.,
2. *Paspalum platycaula*, Linn.,
3. *Paspalum conjugatum*, Berg.,
4. *Eleusine coracana*, Gaertn.,
5. *Andropogon sorghum*, (L) Brot.,
6. *Pennisetum typhoideum*, Rich.,
7. *Panicum crus-galli*, Linn.,

Eleusine indica, Gaertn. and *Eleusine aegyptiaca*, Desf. have not been found suitable.

The eggs which resemble small black seeds are laid in rows on the padi leaves and hatch in from 6-8 days. The young bug is similar to the adult but without wings and feeds by piercing the developing grain or stems and sucking the juices.

From the hatching of the egg until the adult condition is reached there are five moults. From 16-20 days are passed in the nymphal stages making a variation of 22-28 days for the life cycle.

Eggs have been found parasitised by a small Chalcidoid and the nymphs and adults are reduced in numbers by a Reduviid bug.

The most important result obtained during these investigations is the wide variety of food plants utilised by this insect.

This shows the necessity of keeping down grasses in the vicinity of padi areas, both when supporting padi and when fallow, in order to reduce the number of *Leptocorisa varicornis* attacking the next padi crop.

Podops coarctata, Fb.

This bug, known as " Kutu bruang " in Malaya, has been studied in detail, and a manuscript concerning its life history and control has been prepared for publication.

The principal results obtained from this investigation are:

(1) *Podops coarctata* may entirely prevent the formation of padi grain by sucking the sap from the stems of the plants.

(2) The eggs are laid in groups generally at the base of the stems but may be deposited in the soil or further up the stems.

(3) The majority of the eggs hatch in 4 days, though there is a variation of 3-6 days for the incubation.

(4) The largest number of eggs found in one group was 66 but the average was 38.

(5) The bug moults five times before attaining the adult or winged stage. The shortest time found for the nymphal stages was 29 days. First stage nymph 3 days, second stage 5 days, third stage 6 days, fourth stage 7 days, and the fifth stage 8 days.

(6) *Podops coarctata* has been found on " Rumput Gumpai " (*Panicum auritum*) and " Rumput Sendayan " (*Carex. sp.*), in swampy places on grasses, on both dry and wet padi in the nursery and field, on every part of the padi plant including root and leaf, in cracks in the soil, under heaps of partially decayed padi and grasses prior to and after transplanting, under lumps of earth after the land has been ploughed for the next padi crop, and between padi crops on volunteer padi, padi stubble, and grasses.

(7) *Podops coarctata* has to be in large numbers for padi to show serious injury but in small numbers there is always a reduction in the yield of grain.

(8) *Podops coarctata* would seem to thrive best where there is stagnant water, and worst where conditions are dry.

(9) A Chalcidoid parasite has been observed as an enemy of the eggs of *Podops coarctata*. This parasite may complete its life

cycle in 7 days from the time of depositing an egg in the egg of the bug.

(10) Eggs collected have shown a percentage parasitisation of 72.9. This illustrates the influence that this parasite has in controlling "Kutu bruang" when it is present.

(11) The control of this insect should take the form of preventing as far as possible volunteer padi and grasses growing between padi crops, collecting egg masses from seedlings before and after transplanting and placing them in parasite cages, and spraying with tuba root extract where plentiful. If water is available flooding the area and collecting nymphs and adults from the surface has proved effective.

Diatraea auricilia, Dudgeon.

This insect until comparatively recently was an unrecorded pest of Padi in Malaya. It is generally distributed and the injury is caused by the caterpillars "boring" the padi stem.

The eggs are frequently highly parasitised. They should be collected and placed in suitable receptacles allowing the parasites to emerge and continue their useful control work.

Sufficient material has been obtained for a special bulletin on this insect.

Insects on Rubber.

The majority of insects on rubber are of very little importance and no insect of economic significance attacking rubber has been recorded during the year.

Below will be found a list of some of the insects which have been reported or observed during the year on "Hevea" and its products.

From Flowers.

Eurystylus sp. [*Capsidae*].
Hemithea costipunctata, Moore. [*Geometridae*].
Euproctis scintillans, (?) Walk. [*Lymantriidae*].

From Budded Rubber.

Epilachna indica, Muls. (reported). [*Coccinellidae*].

From Leaves.

Hypomeces squamosus, F. [*Curculionidae*].
Tiracola plagiata, Walk. [*Hadenidae*].

From Trunk.

Platypus lepidus, Chap. [*Scolytidae*].

Various caterpillars of moths (unidentified) feeding on lichens and tapping surface.

From Dead Trunk.

Clitellaria obesa, Walk. [*Stratiomyidae*].
Aulana confirmata, Walk. [*Stratiomyidae*].
Atractocerus emarginatus, Cast. [*Lymexylonidae*].
Omadius seticornis, Westw. [*Cleridae*].
Caenorychodes serrirostris, F. [*Brenthidae*].
Anancylus griseatus, Pasc. [*Lamiidae*].

From Decayed Rubber Seed.

Doloessa viridis, L. [*Pyralidae*].
Tenebroides mauritanicus, L. [*Trogositidae*].

From Rubber Seed Oil Cake.

Tribolium castaneum, Hornst. [*Tenebrionidae*].
Araecerus fasciculatus, de Geer. [*Anthribidae*].

Slugs on Rubber Trees.

Slugs were found to be the cause of considerable damage to about 64 acres of young rubber by ascending the rubber trees at night and eating the buds. In their place adventitious buds developed which in turn were attacked so that the branches eventually assumed a truncated appearance.

The damage was considerable and growth had been retarded.

In the day time the slugs were found under the protection afforded by various cover crops and weeds.

MISCELLANEOUS.

Necrobia rufipes, Fb. "Red legged Ham beetle".

This bright blue beetle is cosmopolitan and has been reported in ham, bacon, fish manure, hides of animals, bones, dried blood, copra, and such like materials.

This insect came to the notice of the Agricultural Department, not on account of its damage to copra, but owing to its being a nuisance in bungalows in the vicinity of copra stores.

This insect has been successfully bred from egg to adult on copra but it is generally recognised as predaceous.

The beetle and larva are more abundant in copra which has been undercured or kept in store.

Preliminary life history studies show that eggs are laid in groups. The eggs hatch in 4 days, the minimum time for the larval stage 69 days, and the minimum time in the cocoon 15 days, making a

minimun of 88 days from the laying of the egg to the emergence of the adult from the cocoon. In the cocoon, there are inactive larval, pupal, and inactive adult stages.

Control.

Adults are attracted to Light Traps but it is doubtful if this method of control can be considered effective.

Copra containing adults and larvae was fumigated for 24 hours with Hydrocyanic acid gas, prepared from the generally accepted formula for fumigation purposes.

When the copra was examined, all beetles and larvae were found to be dead, demonstrating the effectiveness of fumigation, but the expense of building a fumigating room (or of buying tarpaulin), of handling and of purchasing material would be very heavy.

The copra was examined by the Agricultural Chemist, who stated in his report that the Prussic acid found in the fumigated copra after exposure to the atmosphere for 24 hours was 1 part in 250,000, for 48 hours was 1 in 500,000, and for 48 hours followed by exposure to the sun for one day and then exposed to the atmosphere for a further three days was nil.

He concluded his report as follows:—

"The results indicate that, by exposing the copra to the sun and atmosphere as above, prussic acid is eliminated. After the fumigation period, the copra should be spread in thin layers in the open, provided the weather is dry."

Grasshoppers.

Two local outbreaks of grasshoppers have been reported.

The grasshopper, which increased to large numbers at Sepang, was *Orthacanthacris nigricornis*, Burm.—a generally distributed species throughout Malaya.

Grasshoppers recently reported at an estate on the Bernam River have not been received. This insect is probably *Cyrtacanthacris luteicornis*, Serv.—a grasshopper which was reported doing damage to coconut palms in 1921 at Kuala Selangor.

Prays citri, Mill.

The caterpillars of this small moth are found feeding in the rind of Limes. After decay has commenced a small Nitidulid beetle (*Carpophilus dimidiatus*, F.) and maggots of the fly, *Drosophila lurida*, Walk. are frequently seen. The original damage is caused by *Prays citri* and control measures only concern this insect.

Crocidomera robusta, Moore.

The caterpillars of this moth are frequently found boring the fruits of various Citrus plants.

The first consideration in the control of this insect is to collect and dispose of all attacked and fallen fruits.

Cephonodes hylas, Linn.

Observations on this insect have been made.

This hawk moth may be seen during the middle of the day flying actively and laying its eggs on the leaves of Coffee.

The eggs are laid singly on any convenient part of generally the most tender leaves. The majority of eggs are deposited on the upper surface of the leaf. The eggs hatch in 3 to 4 days and the larvae are full grown in from 18-21 days when they enter the soil and, having made a cocoon, change to pupae. The pupal stage lasts from 11 to 15 days.

Collecting the pupae from the soil and destroying them and spraying the trees with Lead Arsenate at the rate of 2 lbs to 50 gallons of water has proved successful in the control of this insect.

Phragmataecia parvipunctus, Hampn.

This moth belongs to the family *Cossidae* and the caterpillar bores in sugar-cane in Malaya.

Our records do not show this insect occurring as a pest in other countries.

Earias fabia, Stoll. and *Earias insulana*, Boisd.

The caterpillars of these two moths have been observed on several occasions damaging the "bolls" of Cotton.

Erionota thrax, Moore.

The caterpillars of this butterfly are responsible for rolling Banana leaves in Malaya. Under the protection of the rolls the caterpillar feeds and ultimately changes to a pupa.

The egg hatches out in about 5 days, the larval stage lasts about 25 days and the pupal stage 10 days making a total of about 40 days for this insect to complete its life cycle.

The eggs are very conspicuous on the leaves and should be hand collected before damage by the caterpillar is done. All rolls should be cut off, but since the larvæ are often very highly parasitised, they should be placed in properly constructed boxes to allow the parasites to emerge.

Epilachna indica, Muls.

This insect which is a Coccinellid pest of Brinjal, *Datura* and related plants has been given attention and will form the subject matter of an article in the Malayan Agricultural Journal.

Termites. (White Ants).

Enquiries concerning white ants in buildings have received attention.

(4). Identifications.

Most insects of considered economic importance to plants have been now identified by the officers of the Imperial Bureau of Entomology.

(4) Future Investigations.

Detailed entomological investigations have been confined to the principal insects on coconuts and padi, but during the coming year studies of the major pests of cotton and sugar will receive greater consideration.

Insecticides will form a prominent part of the entomological programme.

ANNUAL REPORT OF THE AGRICULTURIST FOR 1922.

By F. G. Spring.

Mr. Spring, Agriculturist was in charge of this section of the Department throughout the year.

Mr. T. D. Marsh, Assistant Agriculturist was in charge of Kuala Lumpur, and Batu Tiga Experimental Plantations, until the 13th of July, when he took over charge of Castleton Estate, Teluk Anson.

Mr. Curtler, Assistant Agriculturist assisted the Agriculturist at headquarters from the date of his appointment until the 1st of June, when he was transferred to the Experimental Plantation, Serdang.

Mr. E. Farquharson, Assistant Agriculturist was in immediate charge of the Gunong Angsi Experimental Plantation, the Public Gardens, and the grounds around Government House, Carcosa, and the Sultan of Perak's Lodge, Kuala Lumpur; but took on additional duties at headquarters when the two officers referred to above were transferred.

Mr. E. Mathieu remained in charge of the Government Plantation, Kuala Kangsar, throughout the year.

The Experimental Plantations at Batu Tiga, and Gunong Angsi, were closed on the 1st of August, and 21st September, respectively. All seedlings of economic importance in the nursery beds at Batu Tiga, were removed to the Kuala Lumpur Gardens and a good stock of seed obtained from trees growing there.

Experimental Plantations.

The following shows the expenditure and receipts from the Experimental Plantations Kuala Lumpur, Kuala Kangsar, Batu Tiga, and Gunong Angsi, during the year.

Total upkeep expenditure, Experimental Plantation, Kuala Lumpur	$18,393.52
Total upkeep expenditure, Experimental Plantation, Kuala Kangsar ...	4,671.94
Total upkeep expenditure, Experimental Batu Tiga	4,623,44
Total upkeep expenditure, Experimental Plantation, Gunong Angsi ...	5,116.53
Receipts of Rubber sold	2,831.37
„ plants and seeds sold ...	2,976.98
„ total produce	5,808.35

The amount of rubber, in store, at the close of the year was approximately 8,435 lbs.

All buildings were maintained in thorough repair, whilst roads, and drains, were kept in good condition.

General Information.

The special feature in respect of agriculture, during the year has been the interest shown in crops other than rubber and coconuts.

Lectures on the elementary principles of Agriculture were given to Malay Probationers employed by the Department.

Malayan-Borneo Exhibition.—Messrs. Spring and Farquharson were on duty in Singapore in connection with this exhibition. Growing specimens of various fibre-producing plants, oils, cover crops, catch crops and grasses were exhibited also samples of the products, prepared from the respective crops. Photographs of the plants were also shown. Articles were contributed on the following subjects for the Handbook of Malayan Agriculture:—Agricultural Practice in Malaya, Cereals, Vegetables, Rubber, Oils, Fats, Fibres and Possibilities of other crops of economic importance.

Mr. Spring continued to act on a Committee for the management of the Batu Caves Tamil Settlement and was Honorary Secretary of the Gardens Committee.

The nursery beds at Kuala Lumpur Experimental Plantation, were considerably extended. Many of the old nurseries were planted up with legumes for the purpose of green manuring, other plots received an application of cattle manure.

A price list of economic, and non-economic planting material, as supplied by this Department was prepared and published in the Malayan Agricultural Journal.

A visit was made to Tanjong Rambutan Experimental Farm attached to the Central Mental Hospital with the object of advising on experimental work which is being conducted there.

The Agriculturist acted as one of the judges at the Agri-Horticultural Show, Rembau.

Many visits were made to estates in connection with general agricultural matters. The various Government Plantations were inspected periodically as well as the grounds of Government House, Carcosa and the Sultan of Perak's Lodge, Kuala Lumpur. The grounds referred to were maintained in good order throughout the year.

Twenty acres of rubber trees at Weld's Hill, Kuala Lumpur, were cut out. Approximately 50 acres of blukar land situated in Carcosa domain, were cleared.

Rubber.

The systems of tapping in use, to-day, are all on conservative lines as compared with former years. Alternate day tapping is rapidly gaining favour, over daily, and there is much to be said in its favour. One quarter cut is perhaps the most popular system, but one cut on a third, and half spiral, are commonly used.

Tapping experiments were continued. An experiment, to compare the yield obtained from individual trees of various ages, was commenced in the early part of the year and records kept. The object of this test is to select high yielding trees for purposes of bud-grafting. A large number of seedlings have been raised for carrying out this work.

Many demonstrations on bud-grafting of Hevea were given at headquarters and several on rubber estates, throughout the country.

Cover Crops.

It is satisfactory to be in a position to report that there have been more applications for seed of cover crops than in previous years. The growing of cover crops is rapidly gaining favour and their value as green manure and as a means of reducing soil wash is now recognised. On good quality land, *Centrosema Plumieri* is the most satisfactory cover, but unfortunately this legume will not flourish on poor soil. On the poorer soils, the Giant mimosa (*Mimosa invisa*) thrives best and can be recommended for improving the mechanical condition of the soil and reducing surface wash. The Sarawak Bean thrives well on the lighter types of soil which contain a fair proportion of humus.

Prevention of Soil Wash.

There is little that can be added to my report of last year, except that I would again like to draw attention to the necessity of doing everything possible to prevent, or at least reduce, surface erosion.

Fibres.

A great deal of interest has been shewn in the local production of the chief fibres of commerce and special reference might be made of the Roselle fibre in this direction.

Roselle Fibre.—A large stock of Roselle seed has been raised and seventy-four applicants were supplied with planting material and nine applicants with commercial samples of the prepared fibre. There is now a large stock of seed in the country, sufficient for future planting. Several estates have grown this crop satisfactorily, but mention might be made of one estate in Perak where it has already proved a financial success. This property has placed on the market excellent ropes made from Roselle fibre for which there appears to be a good demand. A commercial sample of this fibre grown and prepared by the Department of Agriculture was forwarded to Denmark, and an exhibit of the fibre and rope was prepared on behalf of the

Imperial Institute. Recent experiments have shown the advisability of close planting and it is recommended to broadcast the seed, on a well prepared surface, at the rate of about 20 lbs. to the acre. It is not possible yet to state the type of land best suited for Roselle but it might be mentioned that good growth has been attained on the lighter type of soils. Roselle fibre seems well adapted to Malayan conditions and can be grown on a large, or on a small scale. Roselle is a suitable crop for the small holder, as quick returns are obtainable and machinery is not essential for the manufacture of the fibre. There would appear no reason why ropes should not be manufactured in Malaya and it is hoped that ultimately this industry may be developed to an extent that will, at least, satisfy local requirements.

Bowstring hemp (*Sansevieria sp.*).—The results of experiment show that Bowstring hemp is a very slow grower, and on that account, it is questionable whether it will prove commercially profitable under estate conditions. It thrives well under the shade of old rubber trees, but appears to be of slow growth under any conditions. Samples of Bowstring hemp were forwarded to the authorities at Kew Gardens for identification.

Sisal hemp (*Agave rigida var: sisalana*).—There is no doubt that Sisal can be grown satisfactorily, in the Malay Peninsula, but it must be grown on a large scale of several thousand acres to warrant the introduction of expensive machinery required for preparing the fibre. The same remarks apply to Mauritius hemp (*Furcraea gigantea*). Three estates are growing Sisal hemp experimentally.

Manila hemp (*Musa textilis*).—Seven applicants were supplied with suckers of Manila hemp. A good stock of plants were raised at headquarters and planted out at Serdang Experimental Plantation.

Kapok (*Eriodendron anfractuosum*).—A stock of seed from good yielding trees was obtained from Kuala Kangsar and supplied to eight applicants. Kapok produces very little shade and catch crops should certainly be interplanted. There is little further to state than that contained in my annual report of last year.

Tobacco.

A certain amount of interest has been taken in the cultivation of tobacco for second grade cigars. The Straits and Burma Trading Co., of Kuala Lumpur import Dutch and Burmese tobacco leaf and manufacture the cigars in Kuala Lumpur. It is proposed to provide this company with material grown by the Department and to encourage the local production of the leaf. There have been one or two enquiries regarding the growing of tobacco for the preparation of extract.

Tuba Root (*Derris elliptica*).

The Ministry of Agriculture and Fisheries, London, report that there is, as yet, no trustworthy information concerning the relative toxic contents of different species of Derris or of the varieties of the

species *Derris elliptica*, since botanic specimens have not been obtainable. Every endeavour is to be made by this Department to obtain suitable botanical specimens for purposes of identification. The Ministry further estate that it is at present too early to answer definitely as to the probable demand for the product; but there is no doubt that Derris has valuable insecticidal properties and that it will take its place among the older insecticides, if it is handled in a sound manner from the commercial point of view. An article on Derris carried out jointly by the Ministry's Pathological Laboratory and the Rothamsted Experimental Station will appear in a forthcoming number of the Annals of Applied Biology. This crop can be successfully grown in Malaya and is extensively used by Chinese market gardeners as an insecticide.

Fruit.

A large supply of planting material of various fruits was obtained and it is hoped to maintain a sufficient stock to meet future demands. A good deal of interest has been taken in the growing of fruits and many applications were received for planting material; 2172 seedlings were supplied to 32 applicants. The Agriculturist inspected a fruit plantation belonging to a Chinaman of Singapore and found that this gentleman is growing a remarkably fine orange which appears to be much in demand in Singapore. Marcotted plants can be obtained at $1/- each. This gentleman is also producing quite a good fig. Several estates were visited in connection with fruit cultivation and an additional area, in the Kuala Lumpur Gardens, was planted up with a collection of fruits of good varieties. The Brazil nut trees, in the Kuala Lumpur Gardens, are now fruiting and this, the first crop, is quite satisfactory. The trees are remarkably healthy and are undoubtedly well suited to Malayan conditions. The Department is keeping in touch with the growers of good stock and recommending applicants, who apply for seedlings, to good sources of supply. Fruit culture, in this country, has received little attention. The general method of raising stock has been by seed and little attention has been given to selection. It is unusual for a selected variety to come true to seed consequently some other form of vegetative reproduction is desirable. Some fruits may be reproduced by cuttings, others by layering and marcotting, but the most satisfactory results are by budding and grafting. The importance of improving local fruits is fully recognised by the Department and it is proposed to devote a great deal of time to this branch of agriculture.

Pasture and Fodder Grasses.

An estate in Malacca was visited in this connection and the following grasses planted:—Soudan, Guinea, Australian Blue Couch, Natal Red Top and *Paspalum dilatatum*. All of the above mentioned grasses have done well in the Government Plantations. Any planter wishing to establish a grazing, or fodder grass, should communicate with this office. A great deal can be done to improve our local grasses by cultivation and manuring.

Peas and Beans.

An endeavour is being made to encourage the local production of peas and beans by Chinese market gardeners. The Agriculturist had an interview with the Protector of Chinese and Collector of Land Revenue in this connection.

African Oil Palm (*Elaeis guineensis*).

The yields of the African Oil Palms at Kuala Lumpur Gardens were recorded. This area was manured with vegetable refuse which was turned into soil.

Citronella Grass (*Andropogan Nardus*).

435 lbs. of Citronella grass were supplied to the Agricultural Chemist for experimental purposes.

Exhibits sent to the Imperial Institute, London.

Ground Nut (*Arachis hypogaea*).

Green Gram (*Phaseolus Mungo*).

Cow Pea (*Vigna Catjang*).

Chillies (*Capsicum sp*:).

Lima Bean (*Phaseolus lunatus*).

Black Gram (*Phaseolus Mungo var*: *radiatus*).

Pogostemon Patchouli, leaves and botanical specimen.

Kapok.

Sea Island Cotton.

Mauritius Hemp (*Furcraea gigantea*) rope.

Mauritius Hemp (*Furcraea gigantea*) fibre.

Sisal Hemp (*Agave rigida var*: *Sisalana*) rope.

Sisal Hemp (*Agave rigida var*: *Sisalana*) fibre.

Bowstring Hemp (*Sansevieria sp*:) rope.

Bowstring Hemp (*Sansevieria sp*:) fibre.

Roselle (*Hibiscus Sabdariffa var*: *altissima*) rope.

Roselle (*Hibiscus Sabdariffa var*: *altissima*) fibre.

Coconut (*Cocos nucifera*) rope.

Bombay Hemp (*Hibiscus cannabinus*) rope.

Manila Hemp (*Musa textilis*) rope.

Pineapple (*Ananas sativus*) rope.

Ipecacuanha (dried roots).

ANNUAL REPORT OF THE AGRICULTURIST, GOVERNMENT PLANTATIONS, FOR 1922.

By

B. Bunting.

Staff.

Mr. B. Bunting, Agriculturist, was responsible for the administration of the Government Plantations Pondok Tanjong, Kuala Tembeling, Castleton Estate, Telok Anson, the Experimental Coconut Plantation Sapintas, and the Experimental Plantation, Serdang, and was assisted by Messrs J. N. Milsum, T. D. Marsh and E. A. Curtler, Assistant Agriculturists, and J. Lambourne, Superintendent, Government Plantations.

Mr. Lindsay Vears, Manager, Experimental Plantation, Serdang, left the service on the termination of his agreement on the 13th June.

Mr. J. Lambourne, Superintendent, Government Plantations, proceeded on leave on the 13th July and Mr. T. D. Marsh, Assistant Agriculturist, took over charge of Castleton Estate, Telok Anson, as from that date.

Expenditure and Revenue.

The following shows the expenditure and revenue, both estimated and actual, of the Government Plantations Pondok Tanjong, Kuala Tembeling, Castleton Estate, Telok Anson, the Experimental Coconut Plantation, Sapintas, and the Experimental Plantation, Serdang, during the year.

Expenditure.

	Estimated.	Actual.
Government Plantation, Pondok Tanjong ...	$ 32,000.00	$ 30,587.85
Government Plantation, Kuala Tembeling ...	30,000.00	28,070.72
Castleton Estate, Telok Anson ...	32,750.00	25,248.56
Experimental Plantation, Sapintas ...	80,000.00	75,313.89
„ „ Serdang ...	87,500.00	77,314.34
	$262,250.00	$236,535.36

Revenue.

	Estimated.	Actual.
Government Plantation, Pondok Tanjong ...	$ 23,400.00	$ 31,919.38
Government Plantation, Kuala Tembeling ...	150.00	176.61
Castleton Estate, Telok Anson ...	29,600.00	28,130.41
Experimental Plantation, Sapintas ...	4,160.00	4,130.93
„ „ Serdang ...	474.00	456.60
	$ 57,784.00	$ 64,813.93

The total expenditure for the above Government Plantations for the year was $236,535.36 against $295,557.11 in 1921 which is a reduction in expenditure of $59,021.75, whilst the total revenue for the year was $64,813.93 against $43,451.63 in 1921, or an increase in revenue of $21,362.30.

The reduction in expenditure is due partly to the policy of cutting out a certain amount of development work, which automatically reduced the labour requirements of some of the plantations, and partly to the lower cost of materials for the period under review.

The increase in revenue is attributed to the higher prices obtained for the sale of rubber during the latter part of the year.

Government Plantation, Pondok Tanjong.

Mr. F. W. McCormac was in charge of this plantation throughout the year.

The area of the plantation is approximately 584 acres, which is made up as follows :—

Mature rubber	...	271 acres.
New clearings	...	300 „
Building sites	...	7 „
Waste land	...	6 „

General curtailment of expenditure necessitated the cutting out of all development work on this plantation and the Estimates of Expenditure were reduced accordingly, resulting in a saving of $26,000.00 which had been allowed for this work.

The planted area has been improved during the year by thinning out a number of inferior trees and is now in excellent condition.

With the exception of about 60 acres of low-lying land, liable to flooding, the whole of the mature area was weeded at a cost of 22.5 cts. per acre per month, which gives a figure of $2.70 per acre per annum against $5.02 for the previous year. The weeding of the new clearings, which have been planted up with *Centrosema Plumieri*, cost only 42 cts. per acre per month.

The labour force at the end of the year was made up of 100 Tamils—59 males, 24 females and 17 minors—and 2 others or a total of 102 coolies, which is sufficient for present requirements. The average daily check-roll wages throughout the year was 37.99 cts. per coolie.

The health of the labour has been good and has shown a decided improvement on last year. There were 128 admissions to hospital and 1 death during the year.

All buildings were maintained in good repair throughout the year at very little cost.

The whole of the planted area (271 acres) is in bearing and the system of tapping is one cut on a quarter tapped on alternate days, except for two small areas which are still on one cut on a third alternate days.

A crop of 94,675 lbs of dry rubber was harvested during the year which was collected at a cost of 4.34 cts. per lb. The "all-in" cost for the year was 19.92 cts. per lb against 44.42 cts (under voluntary restriction) in 1921, whilst the average price realised for all grades was 34.38 cts. per lb. compared with 29.27 cts for 1921.

Out of the 20 consignments of rubber despatched to the Singapore Auctions 15 were awarded the Singapore Standard price for Smoked Sheet.

A tapping experiment was inaugurated in July in order to test the relative value of the alternate day and periodic resting system of tapping. Two of the controls are being tapped on alternate days and the other three plots will be tapped alternately for a period of 12 weeks, the experiment being so arranged that one of the three plots under periodic resting will always be tapped over the same period as the controls.

Diseases and pests give a certain amount of trouble but are kept well under control. Pink disease (*Corticium salmonicolor*) and *Ustulina zonata* are the most prevalent, but a fair number of cases of Brown Bast have occurred.

White Ants (*Termes gestroi*) appear to give very little trouble.

Rain was recorded on 191 days during the year giving a total rainfall of 142.04 inches.

Government Plantation, Kuala Tembeling.

Capt. F. J. Ayris acted as Manager of this plantation throughout the year.

The area of the plantation is approximately 930½ acres, which is made up as follows:

Mature rubber	...	325 acres.
Immature rubber	...	131½ „
Cleared but not planted	...	11 „
Building sites	...	9 „
Reserve land	...	454 „

The general appearance of the whole of the planted area is excellent and the rubber trees in both the mature and immature fields look extremely healthy.

A census of the number of tappable trees taken in December showed that 21,903 trees had attained a tappable size on that date.

Most of the immature area is planted with *Centrosema Plumieri* and this leguminous plant produces an excellent cover on this type of land.

The everage cost of weeding the mature area (part clean weeded) was $1.00 per acre and the immature area (part strip-weeded) $3.21 per acre per month repectively. With increased shade produced in the young areas future weeding costs should be considerably reduced.

Roads, drains and bridges have been kept in good condition throughout the year.

The labour force at the end of the year consisted of 97 Tamils—67 males, 24 females and 6 minors and 2 Bengalis or a total of 99 coolies. The average daily check-roll wages throughout the year was 45.71 cents per coolie.

The health of the labour force has shown further improvement and is now very good indeed. There were 63 admissions to Hospital and 3 deaths during the year.

All buildings were maintained in fairly good condition but will require attention next year.

A certificate of Standard Production was obtained allowing for the export of 106,960 lbs. of dry rubber in respect of this plantation, but it was considered more economical to produce this rubber on other Government plantations where experiments in tapping, etc., were being carried out.

Diseases and pests are kept well under control. A few cases of Pink disease have been reported from time to time, whilst isolated trees were attacked with White ants.

Rain was recorded on 169 days during the year, giving a total rainfall of 101.52 inches.

Castleton Estate, Telok Anson.

Mr. J. Lambourne, Superintendent, Government Plantations, was in charge of this estate until he proceeded on leave on the 13th July, when Mr. T. D. Marsh, Assistant Agriculturist, took over charge as from that date.

The area of the estate is 208 acres, which is made up as follows :—

Mature rubber	... ...	197 acres.
Coconuts	... ...	6½ ,,
Building sites	... ...	4½ ,,

The whole of the area under rubber is kept in a clean weeded condition. The average cost of weeding was 20.35 cents per acre per month or $2.44 per acre for the year.

The labour force at the end of the year consisted of 71 Tamils—55 males, 12 females and 4 minors—and 2 others, or a total of 73 coolies. The average daily check-roll wages throughout the year was $39.80 cents per coolie.

The general health of the coolies was very good indeed, there being only 4 admissions to Hospital and no deaths during the year.

All buildings were maintained in thorough repair and are sufficient for future requirements.

The whole of the planted area is in bearing and the system of tapping is one cut on the quarter daily. The total number of trees on December 31st was 16,307 or an average stand of 82 trees per acre.

The amount of dry rubber harvested during the year was 88,261 lbs., which is equivalent to an average yield of 447 lbs. per acre per annum.

The average cost of tapping and collecting was 6.5 cents per lb. whilst the "all-in" cost of production was 29.08 cents as against 37.36 cents in 1921. This includes all experimental tapping which is responsible for the comparatively high costs under this heading.

The experiments on different systems of tapping, individual yield of trees, various methods of cultivation, and the effects of thinning-out on yield of rubber were continued throughout the year.

A few small trial plots of minor economic crops interplanted amongst the coconuts were laid down from time to time and the results of these trials carefully recorded.

Diseases and pests were kept under control. Brown Bast and *Sphaerostible repens* have been recorded from time to time as well as isolated cases of Die back (Diplodia).

White Ants do not give very much trouble.

Rain fell on 168 days during the year, giving a total rainfall of 90.40 inches.

Experimental Coconut Plantation, Sapintas.

Mr. F. G. Parkin has been in charge throughout the year; Mr. F. J. Norman, Temporary Assistant, resigned his appointment on the 5th April.

The area of the plantation is 2122½ acres, which is made up as follows:

Coconuts	...	938.1 acres.
Rubber	...	88.6 ,,
Cleared but not planted	...	64.3 ,,
Felled and part cleared	...	67.1 ,,
Building sites	...	17.3 ,,
Waste land	...	45.5 ,,
Reserve Land	...	901.6 ,,

In view of the necessity for curtailment of expenditure all development work was suspended and, with the exception of supplying a number of vacancies in the selection block, no planting was done during the year under review.

The general appearance and growth of both the old and young coconuts areas has shown considerable improvement. Of the young areas of coconuts (tall variety), planted in October—November 1919 and January 1920, a number of palms are already flowering and the same applies to the Dwarf or King coconuts planted in September to December 1920.

The area under rubber has also shown improvement and a census of the tappable trees taken in August showed that there were 3660 trees of a tappable size on that date.

Of the area planted with coconuts approximately 306 acres were under Giant Mimosa (*Mimosa invisa*), 109 acres under experimental cover crops (various types), 27 acres under sweet potato (*Ipomea batatas*), 178 acres clean weeded and the remaining 318 acres under grass weeding.

The whole area planted with rubber is under Giant Mimosa, but owing to the increased shade produced by the trees it is now gradually dying out.

The average cost of weeding the whole of the coconut area was $1.64 per acre and the rubber area $1.03 per acre per month, respectively. This is perhaps a rather high figure but in view of the heavy nature of the soil, which necessitates fortnightly weeding on the clean weeded areas, it cannot be considered excessive.

Lalang is troublesome in the areas under grass, but has been kept well under control.

The experiments with various leguminous and non-leguminous cover crops were continued and the following covers were under trial at the close of the year: *Centrosema Plumieri*, *Mimosa invisa*, *Clitoria cajanifolia*, *Dolichos hosei*, *Tephrosia candida*, *Sesbania aculeata*, Passion flower and Sweet potato. The area under experiment, including 4 clean weeded controls, was approximately 72 acres.

The cleaning out and deepening of the field drains on an area of 543 acres was completed during the year, in addition to scupper draining a further area of about 250 acres. This has resulted in a considerable improvement in the drainage system and its effect should be shown in the increased growth of the palms in the near future.

The foundations of the watergate erected in Fields 1—2 collapsed in March and as it could not be repaired it was found necessary to erect a new gate further back from the river. This is now working satisfactorily.

Mounding and ridging was carried out on the low-lying peat area and should prove beneficial to the palms which were beginning to fall over in this area.

The roads and bridges have been kept in good condition.

Stacking and burning of timber on an area of about 225 acres was completed during the year and the whole estate is now practically clean cleared of all timber.

Supplying was carried out where necessary and altogether 6536 vacancies were supplied in the coconut area.

The labour force at the end of the year consisted of 358 Tamils —242 males, 77 females and 40 minors --and 2 Malays, or a total of 360 coolies which is a reduction of nearly 200 on the total employed on the same date last year. The average daily check-roll wages throughout the year was 37.72 cents per coolie.

The general health of the coolies continues to be very good. There were 405 admissions to Hospital and 10 deaths, 4 women and 6 children, during the year.

Buildings were maintained in thorough repair and the corrugated iron roofs were repainted where necessary.

A crop of 120,608 nuts was harvested during the year against an estimate of 96,000. Of the crop harvested 118,233 nuts were made into copra, producing 452.73 piculs, which was sold at an average price of $8.99 per picul. The balance of 2375 nuts were sold at an average price of 2.53 cts. each.

The total amount realised for the sale of nuts and copra was $4130.90 against $1599.35 for the previous year.

The average number of nuts required to make a picul of copra was 261 which is fairly high on account of the large number of small nuts from palms just coming into bearing.

A census of the coconut palms taken in July showed that there were 6845 palms in bearing and a further 1994 palms flowering in Fields Nos. 1 to 12 (395.4 acres) which is nearly 50% of the palms on this area.

Diseases and pests on the coconut area give a little trouble, but are kept well in check by the pest gang. White ants and beetles are the most common, whilst locusts, which are harboured by the Giant Mimosa, have been responsible for the destruction of a number of supplies.

Pig and bear have also been very troublesome in the newly planted areas in spite of fencing precautions. Isolated cases of Bud-rot, Pestalozzia and Transverse leaf-break have occurred and been treated.

In the rubber area White ants have caused a certain amount of trouble, whilst a few cases of Fomes and Pink Disease have occurred from time to time.

Rain fell on 149 days during the year giving a total rainfall of 78.80 inches.

Experimental Plantation, Serdang.

Mr. Lindsay Vears was in charge of this plantation until the 13th June, when Mr. E. A. Curtler, Assistant Agriculturist took over charge of the labour as from that date.

Mr. J. N. Milsum Assistant Agriculturist, remained in charge of the experimental work throughout the year and was transferred to the plantation on the 1st August.

The Agriculturist Government Plantations, who was held responsible for the general supervision of the work of opening up and laying out of this plantation paid regular weekly visits of inspection and devoted a large amount of time to superintending the various planting operations in progress during the year under review.

An area of about 350 acres of good flat land, particularly suitable for experimental work with annual crops, was added to the plantation during the year, which makes the total area of the plantation approximately 1525 acres, half of which is hilly land and the other half either flat or undulating.

At the close of the year there was an area of roughly 450 acres of land clean cleared of all timber and the major portion of it was either planted or prepared ready for planting. The greater part of this area having been ploughed by tractors the land was absolutely freed of all roots and timber, making it most suitable for the cultivation of annual crops which require replanting periodically.

A block of 10 acres was specially reserved for a permanent nursery for the propagation of planting material and the area was systematically laid out in half-acre plots, which are so arranged that they can be either reduced or increased in size according to requirements. Good wide roads have been placed through and round the area and a bamboo fence planted on all sides of the boundary.

An area of 50 acres has been specially reserved for an arboretum which will be planted up with small plots of trees and shrubs likely to prove of possible economic importance. Careful observation will be made of anything planted in this area and should any plant prove to be of economic value it will then be planted out on a field scale to test its possibilities from an economic standpoint.

Fairly extensive drainage operations were carried out during the year and in addition to draining the opened area of 450 acres the main drain round the boundary of the new 350 acre block was completed and as these drains have been thoroughly tested

during the recent wet season I am able to report that the whole of the drainage system is working most efficiently. The proper control of the water passing through the plantation has not only considerably improved the opened area but has had the effect of drying up the 350 acre block of unopened land on the Eastern boundary, part of which will be felled and planted next year.

Excellent progress has also been made in the construction of permanent connecting roads dividing up the different blocks on the opened area and these are gradually being covered with laterite as transport and labour permit of this work being carried out. On all roads constructed through the hilly or undulating areas a row of citronella grass has been planted on each side of the road to prevent any damage from wash. There is plenty of good laterite available on the plantation for the construction of roads for the transport of materials throughout the opened area.

With the exception of a few coolies employed on nursery work, there was no resident labour force on the plantation, and the work of opening up was done partly on contract and partly with casual Chinese labour engaged locally from day to day. The average number of coolies employed daily was 241 and the rate of pay averaged 45 cents per coolie per diem.

Although isolated cases of malaria were reported during the year the health on the plantation was fairly satisfactory.

Good progress has been made in the planting out of the various crops in the field and full advantage was taken of the favourable conditions for planting up the cleared areas during the wet seasons.

The following gives the approximate areas of the principal crops which had been planted out at the end of the year :—African Oil Palm 50 acres, Kapok 50 acres, Sisal Hemp 25 acres, Mauritius Hemp 25 acres, Sugar Cane (10 Malay and 13 Javanese varieties) 25 acres, Coffee (5 varieties) 10 acres, Croton oil 9 acres, Candle Nut 8 acres, Sugar Palm 7 acres, Coca (cocaine) 5 acres, Manilla Hemp 4½ acres, Sea Island and Egyptian Cottons 4 acres, Roselle Fibre 2½ acres, Bananas (approximately 100 varieties) 2 acres, in addition to an area of 10 acres, in the permanent nursery, planted with small plots of miscellaneous crops of which we have not yet obtained sufficient stocks of planting material to plant out on a field scale.

At the end of the year several fairly large blocks were prepared ready for planting and were only waiting more suitable weather conditions.

A collection of the local varieties of Bananas was increased from 46 to about 120 during the year and the different varieties are being isolated as soon as they fruit.

Sufficient stock of the different varieties of Sugar Cane (both Malayan and Javanese) has been obtained to plant up one acre blocks of each variety.

Every effort has been made to collect stocks of planting material for this new plantation and there were roughly 100 different species of plants established on the plantation at the close of the year.

A start has been made to form a herbarium collection of economic plants. A number of plants have already been mounted and will be added to as material becomes available. It is hoped eventually to have herbarium specimens of all the crops being cultivated at the Experimental Plantation.

Diseases and pests give a certain amount of trouble, but were kept well under control. The most serious pest was a swarm of caterpillars of *Tinacola flagiata* which attacked the Sisal Hemp, Mauritius Hemp and Kapok on the Eastern boundary of the unopened area. The caterpillars had been feeding on the adjoining blukar and having eaten most of its foliage passed on in a large army to the planted area.

Fortunately they were discovered before they had time to do much damage and were completely eradicated.

Rain fell on 199 days during the year giving a total rainfall of 87.86 inches. The low rainfall is somewhat compensated for by the large number of wet days.

General.

During the earlier part of the year a considerable amount of time of the officers of this division was devoted to the preparation and collection of exhibits for the Malay-Borneo Exhibition, in addition to the contribution of articles in connection with the Department publication of a handbook on Malayan Agriculture.

Further, the exhibition was responsible for a certain amount of disorganisation of both European and subordinate staff during the latter part of March and beginning of April as several officers were required to be in attendance at Singapore for this period.

A course of lectures in the elementary principles of Agriculture was given to a number of Malay apprentices and probationers attached to the Department. The students were very regular in their attendance of lectures and the results of the examination showed that the majority had attained a good knowledge of the subjects which were included in the syllabus.

Periodical visits were made to all the Government Plantations and reports on their condition were submitted to the Secretary for Agriculture from time to time.

ANNUAL REPORT OF THE AGRICULTURAL INSTRUCTOR, FOR 1922.

By

D. H. Grist.

1. *Organisation.*

The provision of an Instruction Division of the Department of Agriculture was approved on July 1st, 1922, as a provisional and tentative arrangement, subject to review on July 1st 1923. Under this arrangement the writer was placed in charge of the division, to be assisted by Captain Howlett as soon as he could be released from his duties in the library. Captain Howlett did not work in the new division during the year under review.

Under the scheme of organization, it was arranged that the Inspection staff should organise demonstration and experimental work, while under the Instruction division was placed such problems as school gardening, Malay literature, investigations on organization of local industries, literature for local shows, arrangements for examinations etc. of the Malay officers of the Department. In general terms the new division was to place the Department more closely in touch with the Malay cultivator. The work, while mainly connected with native effort, is not confined to such cultivators, for the consideration of the marketing of crops is often of lively interest to alien planters, and much benefit may on occasion result to native agriculture from the interest taken by European planters.

The Staff throughout the year has consisted of the writer and one Junior Agricultural Assistant.

2. *Kapok.*

The steady rise in price of this commodity in the world's markets was a feature of a year of general "Slump," and in consideration of the apparent suitability of Malaya for the cultivation of this crop, the question of its local production was investigated by the Division.

Statistics shewed that there are about 100,000 kapok trees in the Peninsula, about 60,000 of which are within a comparatively small area of Perak. While the actual number of trees is not great, yet it was thought that it was sufficient to justify an attempt at marketing, having regard to the immediate benefit accruing to the cultivator, and the value of this in stimulating the planting of new areas with the crop.

The Agricultural Instructor visited all the districts in Perak where the trees are numerous, and observed that while those of Krian were mostly planted in unsuitable situations, the trees along the Perak River and generally throughout Lower Perak were in a very promising condition.

The value of kapok is unappreciated by Malays, but is well known amongst the Chinese shopkeepers. The result is that little kapok is harvested, other than that required by the owner for his own use, unless its sale to the local shopkeeper is enforced in order to reduce the cultivator's debts to the shopkeeper. It follows that the Malay procures but a small price for his crop—actually about $5 a pikul for uncleaned kapok worth at present about $10—$12.

At the time of this investigation in Perak, the harvesting season was advanced, and, with the object of saving the crop and demonstrating its value, the suggestion was made that the Government might buy kapok at a fixed price, clean it in one of the convict establishments and place it on the local market. Government approval of this suggestion was received too late to put the scheme into operation.

An attempt is to be made to organize the collection, cleaning and sale of the crop in 1923. A European planter has agreed to buy at a fixed rate and carry out the necessary work of cleaning, baling, etc., and as he is situated at a convenient centre on the road, river and railway, there is reason to expect that this scheme will be successful.

Much information has been collected locally, and from other countries, on the cultivation, preparation of floss, and marketing of kapok, and this information has been written up for publication.* The local cultivation of kapok is of interest to all planters in this country because it is a crop conveniently grown in conjunction with other forms of agriculture, can be grown successfully in Malaya, is inexpensive in machinery, commands a ready local sale (Penang alone imported 170 tons in 1921) as well as being in world-wide demand. There was considerable enquiry amongst planters respecting kapok, and within the next two years there should be a largely increased area planted under this crop in Malaya.

3. *Roselle.*

The pros and cons of roselle have been the subject of much discussion during the year. The two main questions that confronted the prospective cultivator at the commencement of the year were:— Labour necessary, and uncertainty of market; and in the inter-relation of these two questions was bound up the whole matter of success or failure, of profit or loss. It was therefore encouraging to find one planter who, himself convinced of its possibilities, planted considerable areas, manufactured rope and string commercially and also sold raw fibre at a good profit in England.

Given the fact that the market was assured, the writer was convinced of the suitability of the cultivation of this crop on native holdings, because it can be made to pay on small areas, and requires absolutely no machinery in its production. A guaranteed price for roselle fibre has been offered by the aforesaid planter to Malays producing fibre, and a number of Malays have now this crop planted on their holdings.

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* Published in M. A. J. XI, No. 1.

While the Department of Agriculture is encouraging the cultivation of roselle amongst all classes of planters, it would appear that a certain amount of caution is necessary, for in the first place, the relative merits of this fibre in comparison to Jute (which is the standard) is still uncertain, for although it would appear that roselle is of better colour, it is said to be more brittle. And secondly, it is observed that roselle plants occasionally suffer very considerably from disease. Practically every plant on one demonstration plot in Ulu Selangor has died through this cause, and occasional attacks have been noted elsewhere. Either of these two causes may result in considerable loss to the planter, but it may certainly be urged that roselle demands a comparatively small outlay of capital and no machinery other than a baler, so that the risk is more restricted than is the case with many other crops.

4. *Exhibitions and Shows.*

Malaya-Borneo Exhibition: The writer was on the Agricultural Committee of the above Exhibition, and was Honorary Secretary of the Agricultural Show Sub-Committee organized in this connection. The Committee arranged, with the co-operation of all the officers in the Department, a departmental exhibit, which was one of the great attractions of the Malaya-Borneo Exhibition; and edited a Handbook of Malayan Agriculture. The Agricultural Show attracted about 15,000 exhibits from all parts of the Peninsula and Borneo.

Much of the writer's time in the first four months of the year was devoted to work in connection with the Exhibition.

The District Shows, provision for which appeared in the Estimates, were not held, owing to the necessity for curtailment of expenditure, consequently the Vote of $1000 which appeared in the Agricultural Estimates, for the provision of literature for these events was not expended.

Private effort is replacing the abandonment of Agricultural Shows under Government auspices. The Negri Sembilan Agri-Horticultural Society is flourishing and held successful shows in Negri Sembilan, while the Malayan Agri-Horticultural Association came into being in October. The aims of this Association are so closely related to some of the objects of this Division, that the writer accepted the invitation of the Association to the office of Honorary Organizing Secretary and Treasurer.

5. *School Gardens.*

Although the Scheme for school gardens was approved before the Instruction Division came into being, no funds were available for commencing the work until August, when the sum of $2,200 was transferred from another vote to the Instruction Division. This enabled a start to be made by the purchase of implements etc. A survey of the schools of Selangor, Negri Sembilan and part of Pahang was made, and the most suitable schools selected. The Agricultural Instructor then met the teachers concerned at Kuala Lumpur, and later, at Seremban, and explained to them the objects of School

Gardening and the method of starting the scheme. A limited number of implements were provided to each school on the request of school gardens, and suitable planting material was also supplied from time to time.

By the end of the year, eight schools in Selangor had started school gardens, and preparations were made for additional schools to commence the work early in 1938. The writer sees evidence of great keenness amongst the children, and a sympathetic interest amongst the teachers. It must be remembered that, at the Agricultural Instructor's suggestion, the system of school gardens was started before the teachers were trained in the work. It is not easy to venture an opinion as to whether this step was justified. Much of the success depends on frequent visits to the schools by Agricultural officers, because the teachers rely on the Department for assistance in various directions in connection with the gardens.

6. *Warta Perusahaan Tanah.*

The first number of a Malay Agricultural Bulletin printed in the Arabic character appeared early in December, the edition being 10,000 copies. It contained articles on *kapas*, cultivation, harvesting and marketing; Rosella-Cultivation and marketing; The subject of School Gardens; a discussion on School Gardens by a Mudir, and an Editorial.

Prior to the publication of this Bulletin the Director obtained from the Districts a list of Malay Chiefs, Malay Government officers, and other Malays of standing to whom the Bulletin should be supplied. In addition, a copy was sent to each school in the country. No charge to the reader was made for the publication, it being treated purely as propaganda work. The result was, in the writer's opinion encouraging, a number of letters were received from Malays in different parts of the country, either thanking the Department for the publication, or asking for further advice on cultivation, diseases and pests, and for the supply of seed. It is necessary to increase the size of subsequent numbers to 3,000 owing to increased demand.

Questions of agricultural interest to Malays continually occur, where it is desirable to supply careful explanations of the reason for Government action; rubber restriction may be cited as a case in point. By the establishment of a direct link between the Agricultural Department and the Malay Public such as obtains through this publication, a ready means is at hand through which to disseminate knowledge, and to clear up misconceptions; a publication such as this should therefore have a political value not to be ignored.

For the present, Warta Perusahaan Tanah will be published quarterly. The second number now in the press includes articles on rubber restriction, the report of the Sultan Idris College Training Malem; the help of manurial pests that can be produced locally; Instructions for starting School Gardens, etc.

7. *The Sultan Idris Training College for Teachers, Tanjong Malim.*
This College was opened in November. The writer was appointed Acting Agricultural Instructor to the College in addition to his other duties. For purposes of giving instruction, he visits the College on Saturday and Sunday each week.

The instruction commenced at the beginning of December, there being 120 Malays taking a course of rural husbandry which is largely of a practical nature.

8. Demonstration plots.

Under the revised scheme of Agricultural Instruction, Demonstration plots are under the charge of the Inspection Division. The Instruction Division assisted in commencing the plots started by the Assistant Agricultural Inspector, Selangor at Batang Kali and Tanjong Malim, where roselle and kapok are planted.

9. Penghulus.

The Instruction Division strives to keep in close touch with penghulus. This is done partly by the publication of the Malay Bulletin and also by visits to the Mukims. A Meeting of penghulus of Kuala Selangor was held on October 21st at which various subjects, such as co-operation, cultivation of roselle, and kapok were discussed. A rather similar meeting was held at Bentong on October 30th attended by all the Penghulus of the District and by several Malay holders and towkays, there being about fifty persons present.

10. Estate Visits.

The Agricultural Instructor has paid 20 visits to estates during the year, either to offer advice or to acquaint himself more fully with particular points in agriculture.

11. Publications.

(*a*) Warta Perusahaan Tanah Vol. 1 No. 1 in November in the Malay language and Arabic character.

(*b*) "Kapok" articles in "Straight Times" July 8th 1922 and in Malayan Agricultural Journal Vol. 10 No. 2.

(*c*) "Wet Padi Planting in Negri Sembilan" Special Bulletin No. 33 of Department of Agriculture.

REPORT OF THE PLANT PHYSIOLOGIST FOR 1922.

By

W. N. C. Belgrave.

Staff.

Mr. W. N. C. Belgrave, Plant Physiologist, Haji Abdul Wahid, Junior Agricultural Assistant, and Inche Jalaludin, Malay Apprentice.

I desire to express my appreciation of the reliability of these two Malay Officers.

Work.

The time of the section has been almost entirely devoted to work on the rubber tree. The work may broadly be divided into field and laboratory work.

Field Work.

Records of individual tree yield have been taken on plots at the Government Plantations, Kuala Lumpur and Batu Tiga and on one estate. The records confirm previous observations that for short periods such as one year there are no significant alterations in order of merit of the trees of a plot, *i.e.* good yielders remain good and poor yielders poor. It is essential that this recording work should continue for a long term of years since improvement by selection ultimately depends on the unproved assumption that such constancy will be shown over prolonged periods.

"*Double V*" *Tapping.*—In view of what then appeared to be the possibility of serious labour shortage in the near future, experiments were started in May on the effect of tapping longer cuts at longer intervals of time than is usual. Two opposite V's girdling the tree were tapped at intervals ranging from 1 to 6 days. The yields from mature trees tapped every 5th day compared favourably with those obtained from the usual alternate day system, and so far no signs of injury have been noticed.

Although the fears of labour shortage appear to have been groundless, the experiments will be continued as several interesting points have emerged which demand further investigation.

"*Thinning Out.*"—Experiments on the effect of early and drastic thinning on subsequent growth and yield have been started.

I desire to express my thanks to those responsible for the direction and management of Estates on which permission has been given for the carrying out of field work.

Laboratory Work.

The main line of work selected for 1922 has been the study of those properties of latex which may be expected to influence flow and

yield. Among these are—viscosity, surface tension, osmotic pressure and acidity, (measured as hydrogenion concentration.) These properties have been studied individually and in their relation to each other, but up to the present it has not been found possible to formulate any general theory embracing the observed facts. Work will be continued. The chief difficulty encountered is that latex is a rapidly changing biological fluid, the condition of which at any moment is the result of the interplay of a number of internal factors.

State of Caoutchouc in Latex.—A study was made of the temperature changes in coagulation and of the co-efficient of expansion of latex compared with that of recently coagulated rubber. Both results suggest that caouthouc in latex exists in the solid state. Further work is required and will be undertaken.

Nitrogen in Latex.—Work has been started on the non-protein nitrogenous bodies, and a certain number have been isolated in a fair state of purity. Two may be mentioned, a lecithin-like substance and a substance with a strongly marked pyrrol reaction. The occurrence of the latter is suggestive in view of an attractive theoretical synthesis for caoutchouc through pyrrol bodies which has been put forward. Quantitative determinations are in progress.

Water Relationships.—Preliminary observations were made on transpiration and root pressure, but time was lacking for detailed work.

General Observations on Rubber.

The slump directed attention to the necessity of reducing costs in all possible directions, and the results of some of the attempts so to do will be of great interest physiologically.

Tapping Systems.—Daily tapping, once almost universal, has lost ground in favour of alternate day tapping over $\frac{1}{2}$ and $\frac{1}{3}$ the circumference. Many estates are experimenting with the "A, B" or "A, B, C" systems; the former involves daily tapping for $1\frac{1}{2}$—$2\frac{1}{2}$ months followed by a like period of rest, the latter daily tapping for $1\frac{1}{2}$—$2\frac{1}{2}$ months with double that period of rest. Time alone will show the advantages and disadvantages of each.

Bud-Grafting.—Great interest has been shown in work in progress in the Dutch Indies on bud-grafted rubber and some bud-grafting has been carried out locally. It is regrettable that hopes, or fears, of extraordinarily high yields are somewhat generally entertained together with some confusion between a demonstrated fact and an experiment. Even assuming the experiment to be a success, it is feared that some of the local work will be rendered useless by lack of sufficient care in selection of mother-trees.

Other Crops.

Nipah Palm.—Some preliminary observations were made on Nipah Palm but the subject does not yet seem to have become important enough to justify the expenditure of further time.

Publications.

No original work was published in 1922, none of the investigations undertaken having reached finality.

The following memoranda were prepared.

Opposite V tapping.

Early and drastic thinning out.

Seed selection.

Two articles were written for the "Hand-Book of Malayan Agriculture."

Reports received for publication 27th July, 1923.

COPY OF NOTIFICATION No. 4780 IN F.M.S. GOVERNMENT GAZETTE, dated 10th August 1923.

No. 16. Vol. XV. Page 1482.

"THE AGRICULTURAL PESTS ENACTMENT, 1913."

Agricultural Pests Supervising Committee.

No. 4780. Under the provisions of section 4 of "The Agricultural Pests Enactment, 1913" the following have been nominated by the Chief Secretary to Government to form, with the Secretary for Agriculture, Straits Settlements and Federated Malay States, as Chairman, the Agricultural Pests Supervising Committee.

The Legal Adviser;

Mr. F. H. Mustard.

(G. 1297/23).

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture: the Raffles Museum, Singapore; and the Malay States Information Agency, 88, Cannon Street, E.C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Volumes I-IX, (1912-1921) price $5.00 per volume, or 50 cents per single number.

The following numbers are out of print:—

Volume V. Number 11 & 12.
" VI. " 2, 3, 4, 5, 6, 9 & 11.
" VII. " 1.

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2. The Malayan Agricultural Journal. Published monthly.

Volume X . . . . . (1922 to date.)

Price $5.00 per volume or 50 cents per single number.

3. The Handbook of Malayan Agriculture.

Price $1.00

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased at the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co.

4. Special Bulletins.

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, Government Entomologist, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, the Para Rubber Tree by W. J. Gallagher, Government Mycologist, 1916, 20 cts.
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, Government Entomologist, 1910, Reprint 1916, 20 cts.
4. A Lepidopterous Pest of Coconuts, *Brachartona catoxantha, Hamps.* (Zygaenidae) by H. C. Pratt, Government Entomologist, 1909, (out of print).
5. The extermination of Rats in Rice-Fields, by W. J. Gallagher, Government Mycologist, 1909, Reprint 1916, 20 cts.
6. Preliminary note on a Branch and Stem Disease of *Hevea Brasilienisis*, by W. J. Gallagher, Government Mycologist, 1909, Reprint, 20 cts.
7. Coffee Robusta, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malaya) 1910, 20 cts.
9. Die-Back Fungus of Para Rubber and of Cacao: by Keith Bancroft, Assistant Mycologist, 1911, 20 cts. (Out of print).
10. A Lecture on the Para Rubber Tree, by W. J. Gallagher, 1910, Reprint, 1916, 20 cts.

11. Coconut Cultivation, by L. C. Brown, Inspector of Coconut Plantations, 1911, 20 cts.

12. Padi Cultivation in Krian, by H. C. Pratt, Government Entomologist, 1911, 20 cts.

13. A Root Disease of Para Rubber, *Fomes Semitostus*, by Keith Bancroft, Assistant Mycologist, 1912, 20 cts.

14. The Die-Back Disease of Para Rubber and a Note on the Leaf Diseases of Para Rubber ; by Keith Bancroft, Assistant Mycologist, 1911, 20 cts.

15. Camphor : its Cultivation and Preparation in the Federated Malay States, by B. J. Eaton, Agricultural Chemist, 1912, 20 cts.

16. The Spotting of Plantation Para Rubber (A Preliminary Account of Investigations on the cause of the Spotting), by Keith Bancroft, Mycologist, 1913, 20 cts.

17. The Preparation of Plantation Para Rubber by B. J. Eaton, Agricultural Chemist, 1912, 20 cts. (Out of print).

18. Agriculture in Malaya, 1912, by L. Lewton Brain, Director of Agriculture, 1914, 20 cts.

19. The Spotting of Prepared Plantation Rubber, by A Sharples, Assistant Mycologist, 1914, 20 cts.

20. Agriculture in Malaya, in 1913, by L. Lewton-Brain, Director of Agriculture, 1914, 20 cts.

21. Pink Disease by F. T. Brooks, Mycologist, and A. Sharples, Assistant Mycologist, 1915, 20 cts.

22. A Disease of Plantation Rubber caused by *Ustulina Zonata*, by F. T. Brooks, Mycologist, 1915, 20 cts.

23. The Tapping of the Para Rubber Tree, by E. Bateson, Assistant Mycologist, 1914, 20 cts.

24. The Malayan Locust, by H. C. Pratt, Government Entomologist, and F. de la Mare Norris, Assistant Agricultural Inspector, 1915, 20 cts.

25. *Ustulina Zonata*—a Fungus affecting *Hevea Brasiliensis*, by A. Sharples, Mycologist, 1916, 20 cts.

26. Vegetable Culture in Malaya, by F. G. Spring, Agriculturist and J. N. Milsum, Superintendent Government Plantations, 1917. Second Edition 1919, 50 cts.

27. The Preparation and Vulcanisation of Plantation Para Rubber, by B. J. Eaton, Agricultural Chemist, J. Grantham and F. W. F. Day, Assistant Agricultural Chemists, 1918, $1.00.

28. A Wet Rot of Para Rubber, by W. N. C. Belgrave, Assistant Mycologist. 1919, 50 cts.

29. Fruit Culture in Malaya, by J. N. Milsum, Superintendent Government Plantations, 1919, $1.00.

30. Food Production in Malaya, by F. G. Spring, Agriculturist, and J. N. Milsum, Acting Assistant Agriculturist, F. M. S. 1919, $1.00.

31. Black Stripe and Mouldy Rot of *Hevea Brasliensis*, by A. Sharples, W. N. C. Belgrave, F. de la M. Norris and A. G. G. Ellis, $1.00. (Out of print).

32. Observations on the Technique required in Field Experiments with Rice, by H. W. Jack, $1.00.

33. Wet Padi Planting in Negri Sembilan, by D. H. Grist $1.00.